# SCIENCE



FRIDAY, MAY 13, 1898.

*CONTENTS:*



MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison-on-Hudson, N. Y.

## *THE NEW YORK ACADEMY OF SCIENCES.*

ADDRESS BY THE PRESIDENT, PROFESSOR HENRY F. OSBORN, AT THE FIFTH ANNUAL RECEPTION.

*Members of the Academy and of the Scientific Alliance: Welcome to the Fifth Annual Reception!*

AN Academy of Science stands as a clearing house for scientific ideas; for the encouragement, diffusion and interchange of methods and principles between all branches. The elasticity of our own Academy is well illustrated in this fifth annual exhibition of the progress of science. Thanks to the energy of our Secretary, Professor Dodge; of the Chairmen of the many different sections and the cooperation of institutions in all parts of the country, it appears to cover a broader field than ever before. Here you can obtain glimpses of the work in many lines progressing at Harvard, the Johns Hopkins, Princeton, the U. S. Coast Survey, Chicago, the Troy Polytechnic, the Allegheny Observatory, besides our own City College, University of New York, Columbia University and, not least, this great Museum.

*Methods.*—Here, too, the methods and instruments of research, as well as the results of work in the most diverse fields of scientific enterprise, are brought together and stimulate us by their very contrast. Our inventiveness is as notable in the beautifully delicate instruments for studying

the human senses displayed by the psychologists as in the apparatus developed by our astronomers and physicists. Beside the newest technique of pure research in the physical and biological sciences, you will find beautiful and diverse methods applied to the arts, to photography, to the manufacture of exquisite glass vases, as well as to the more useful clays from all parts of Europe.

*Explorations.*—True to the Monroe Doctrine, we are no longer allowing France, Germany or any other country to preoccupy our proper scientific territory, and you will observe proofs of especial activity along the noble western coast of the Americas from Cape Horn to Point Barrow, Alaska. From the photographs of Arequipa, Peru, the highest astronomical station in the world, the mosses of northern Bolivia, the Indians of Mexico, we have invaded British territory and are making the study of the North Pacific and the zoology of the Pacific Coast from Puget Sound to Alaska our own. We are also invading other countries by expeditions of various kinds, and our geologists and mineralogists draw their exhibitions from every part of the world, from Tasmania to Finland.

*Diversity of Subjects.*—The subjects treated in this exhibition are as widely separated as these geographical areas; in adjoining alcoves you will find the brains of New Guinea natives and the moth Siamese Twins. Across the aisle, in the field of electricity, signalling without wires is in process, widely in contrast with the concentrated polar cold of the liquid air in the main hall. The monster Camarasaur, at least ten millon years old, from the base of the Cretaceous, puts a Pickwickian interpretation upon the words 'old' and 'rare' as applied to the manuscripts in the department of philology.

*Progress.*—Scientific work day by day appears to drag. It is only when an interval of a few months passes and we have taken stock of things that we realize our immense progress. We are especially encouraged for the future by the generous gifts which are pouring into the service of science in this city. Only a week ago a gentlemen agreed to fit out an expedition to the west coast of Africa. Fortunate is the country where men of brains are drawn into the pursuit of science, and men of appreciation and wealth supply the sinews of scientific warfare. Pure research is a luxury, for it brings no immediate return, but as an investment it finally repays a city or a country a hundred or a thousand fold.

At our annual exhibition last year we signalized electricity as the especial subject of scientific progress in the person of Mr. Nikola Tesla. This year we believe that astronomy deserves the place of honor. American astronomy, reaping, as it does, the combined advantages of our mathematical genius and natural inventiveness, of our wonderfully clear sky, and the support of generous wealth, certainly occupies a commanding position. We, therefore, take pleasure in introducing Professor George E. Hale, who will tell you of the great Yerkes Observatory and the especial merits of large telescopes.

---

## THE FUNCTION OF LARGE TELESCOPES.*

The annual exhibitions of the New York Academy of Sciences afford excellent opportunities for studying the progress of science. The photographs and specimens gathered here to-night are substantial evidence that in no department of research have investigators been idle during the last twelfthmonth. So true is this that to sketch the year's advances in even a single field would consume more time than is allotted to the annual lecture. It therefore seemed to me wise,

* An address given at the Fifth Annual Reception of the New York Academy of Sciences.

in responding to the courteous invitation with which I was honored by the Council, to select a subject involving certain details of astronomical progress, without attempting to undertake the inviting task of portraying the rapid advances which make up the recent history of the science. I accordingly invite your attention to some considerations regarding the function of great telescopes.

On the 21st of last October, in the presence of a large company of guests, the Yerkes Observatory was dedicated to scientific investigation. The exercises were held under the great dome of the Observatory, beneath the 40-inch telescope. Is there reason to suppose that some in the audience, particularly those having no great familiarity with astronomical instruments, were inclined, in the course of the reflections to which the occasion may have given rise, to attribute to the great mass of steel and optical glass rising far above their heads some extraordinary and perhaps almost supernatural power of penetrating the mysteries of the universe? It is not at all unlikely that this was the case. For there apparently exists in the public mind a tendency to regard astronomical research with a feeling of awe which is not accorded to other branches of science. In its power of searching out mysterious phenomena in the infinite regions of space a great telescope seems to stand alone among the appliances of the investigator. Partly because of this special veneration for its principal instrument, and perhaps still more on account of the boundless opportunity for speculation regarding the origin and nature of the universe, astronomy appears to command the interest of a great portion of the human race. No doubt there are also historical reasons for the special attraction which the subject seems to exercise. In the more prosperous days of the countries bordering on the Mediterranean astrology played an important rôle, and mediæval history illustrates most clearly the ascendency which the fancies of the astrologers had acquired over even cultivated minds. So strong was the tendency of the times that even so able an astronomer as Tycho Brahe was wont to cast horoscopes, in the significance of which he firmly believed. He concluded that the new star of 1572 prognosticated great changes in the world. Similarity to the ruddy planet Mars pointed to wars, pestilence, venomous snakes and general destruction, and its resemblance to Venus, Jupiter and Saturn at other times foretold temporary pleasant influences, followed by death and famine.* Thus the heavenly bodies in their courses were supposed to exercise evil or benign influences upon the human race, and the apparition of a great comet or a new star gave rise to endless speculations regarding the fate to which the inhabitants of the Earth were shortly to be exposed. Even in our own day it cannot be said that we have altogether escaped from the entangling meshes of the astrological net. With that strong desire to be humbugged which Dr. Bolton has so well illustrated in his recent paper in SCIENCE on Iatro-Chemistry, a portion of the general public seems to devote itself with enthusiasm to the encouragement of charlatans, whether they deal with alchemy, with medicine or with astrology. So it is that astrologers flourish to-day, and continue to derive profit from their philanthropic desire to reveal the future to inquiring minds.

The interest of cultivated persons in astronomy and in the possibilities of great telescopes is by no means to be compared with the blind groping of less developed intellects after the mysteries of astrology. But if we must regard the large circulation of certain newspapers as any index to the popularity of their contents, we are forced to admit that their readers may comprise a

* See Dreyer's *Tycho Brahe*, p. 50.

class of persons whose admiration for the science is at least distantly related to the love for the sensational which dominates the followers of modern seers and sooth sayers. Great telescopes are no sooner erected than these papers begin to demand extraordinary revelations of celestial wonders. The astronomer, quietly pursuing his investigations in the observatory, is from time to time startled by imperative demands to introduce a waiting and anxious public to the equally expectant inhabitants of Mars. Minute particulars as to the appearance, strength, stature and habits of these hypothetical beings, whose existence is freely taken for granted, are expected to be the results of a few moments' observation with the great telescope. When the astronomer mildly protests that his observations are likely to afford little or no material for discussions of such topics, he is at least supposed to so cultivate his imaginative powers that he shall be able to supplement his unsatisfactory observations by intuitive perception of things which are beyond his telescope's unaided appreciation. And it must be admitted that this demand on the part of some portion of the public press, while in one sense only a certain phase of the almost universal desire for sensation, has not lacked encouragement from men who are generally regarded as serious astronomers, intent on arriving at the truth by the methods of exact science. To such is due a widespread belief in the inhabitants of Mars, who in the popular novels of the day have not even been content with life upon their own planet, but, in accordance with the astrological significance of the god of war, have come to bring destruction upon the inhabitants of the Earth. However entertaining we may find the doings of these strange individuals, whether at home or abroad, we must not make the mistake of classing the works which describe them with the literature of science, but rather accord them their proper place among the pleasant romances which we owe to men of letters.

I cannot better illustrate one phase of this pseudo science than by a reference to the celebrated 'Moon Hoax,' which caused such a stir at the time of its appearance. When Sir John Herschel sailed for the Cape of Good Hope in 1833 he little imagined what marvelous discoveries lay before him. It is true that he was provided with a great reflecting telescope of twenty feet focal length, which was to be used upon the previously unexplored regions of the southern heavens, and it could not have been difficult for him to form some conception of the valuable additions he was certain to make to astronomical knowledge. But the imagination of others by far outran the more prosaic course of his own mind, and results were obtained for him which unfortunately his telescope never served to show. Many who are present are no doubt familiar with a pamphlet entitled 'Great Astronomical Discoveries lately made by Sir John Herschel, LL.D., F.R.S., etc., at the Cape of Good Hope,' which was 'first published in the New York *Sun*, from the supplement to the *Edinburgh Journal of Science*.' In the truly entertaining pages of this ingenious narrative we find an example which certain reporters of our own day seem to have taken to heart. Let me quote a paragraph of nonsense which is so amusingly conceived and proved so effective when published that one is almost ready to forgive the perpetrator. After a lucid historical discourse on the great telescopes which had been made by Sir William Herschel and other previous investigators, followed by an impassioned paragraph which may well be considered to approach in eloquence the most fervid astronomical literature of our own day, our author treats us to an account of a conversational discussion between Sir John Herschel and Sir David Brewster, which began with a consideration of certain

suggested improvements in reflecting telescopes, and soon directed itself "to that all-invincible enemy, the paucity of light in powerful magnifiers. After a few moments silent thought, Sir John diffidently inquired whether it would not be possible to effect *a transfusion of artificial light through the focal object of vision!* Sir David, somewhat startled at the originality of the idea, paused awhile, and then hesitatingly referred to the refrangibility of rays and the angle of incidence. Sir John, grown more confident, adduced the example of the Newtonian reflector, in which the refrangibility was corrected by the second speculum, and the angle of incidence restored by the third. 'And,' continued he, 'why cannot the illuminated microscope, say the hydro-oxygen, be applied to render distinct, and, if necessary, even to magnify the focal object?' Sir David sprung from his chair in an ecstacy of conviction, and, leaping half-way to the ceiling, exclaimed, 'Thou art the man!' Each philosopher anticipated the other in presenting the prompt illustration that if the rays of the hydro-oxygen microscope, passed through a drop of water containing the larvæ of a gnat and other objects invisible to the naked eye, rendered them not only keenly distinct, but firmly magnified to dimensions of many feet; so could the same artificial light, passed through the faintest focal object of a telescope, both distinctify (to coin a new word for an extraordinary occasion) and magnify its feeblest component members."

Here, indeed, was a discovery fit to startle the world; and one cannot be surprised that, after so extraordinary an advance, Sir John Herschel should have immediately arranged for the construction of an object-glass 24 feet in diameter. Contributions towards this important work were received from many royal personages, culminating in a gift by his Majesty the King of some seventy thousand pounds, which was considered ample to meet all expenses. Many difficulties were encountered in casting the great object-glass, which was composed of "an amalgamation of two parts of the best crown with one of flint glass, the use of which in separate lenses constituted the great achromatick discovery of Dolland." Notwithstanding the prodigous size of this enormous lens, which weighed 14,826 pounds after being polished, and whose estimated magnifying power was 42,000 times, Sir John was not satisfied. Not content with the mere illuminating power of the hydro-oxygen microscope, "he calculated largely upon the almost illimitable applicability of this instrument as a second magnifier which would supersede the use and infinitely transcend the powers of the highest magnifiers and reflecting telescopes." Indeed, so certain was he of the successful application of this idea that he counted upon "his ultimate ability to study even the entomology of the Moon in case she contained insects upon her surface."

It would be interesting, if time permitted, to consider with our inspired author the various further details in the construction of a telescope which was the first to render visible the inhabitants of the Moon. It may well be imagined with what breathless interest the report of Sir John's extraordinary discoveries, which constitutes the body of our pamphlet, was received by a willing public. "It was about half past nine o'clock on the night of the tenth, the Moon having then advanced within four days of her mean libration, that the astronomer adjusted his instruments for the inspection of her eastern limb. The whole immense power of his telescope was applied, and to its focal image about one-half of the power of his microscope. On removing the screen of the latter, the field of view was covered throughout its entire area with a beautiful distinct and even vivid representation of *basaltic*

*rock.*" For further details regarding the rock and the lunar flora which covered it, reference must be made to the original pamphlet. There, too, can be found descriptions of deep blue oceans, breaking in large billows upon beaches of brilliant white sand, girt with wild castellated rocks. Passing inland wide tracts of country of apparently volcanic character were rapidly passed over, soon bringing to the observer's eye lofty chains of slender pyramids of faint lilac hue, which, when examined with the highest power of the instrument, were seen to be monstrous amethysts reaching to the height of sixty to ninety feet, and glowing in the intense light of the Sun. It must not be supposed that such delightful regions were devoid of life. Birds and beasts of strange and uncouth form were soon brought to view, and, last and greatest marvel of all, the observer was permitted to behold beings of manlike form. Although not seen engaged in any work of industry or art, they were evidently of a high order of intelligence, and to them was doubtless due a magnificent temple, built of polished sapphire, with roof of yellow gold. The observer did not at the moment pause to search out the mystery symbolized in the unique architectural details, for he was then "more desirous of collecting the greatest possible number of new facts than of indulging in speculative theories, however seductive to the imagination."

But we have already dwelt too long upon this product of enterprising journalism, which poor Sir John was too far away to be able to contradict. It is enough to remark that the author accomplished his immediate purpose, and moreover bequeathed to future generations a classic in this special field of literature.

The astronomer of to-day is unfortunately exposed to similar misrepresentation. On account of the fact that it is a little larger than any other refractor, the Yerkes telescope is particularly open to attack. Take, for example, these sentences from a newspaper which would not ordinarily be considered as one of the sensational class: "After Professor Barnard had swept the sky in the region of the nebulæ he pointed the instrument toward a region located to the astronomer in Pos. 312 degrees; Dist. 53 minutes. He swung the giant tube toward the region and the first discovery at the Yerkes Observatory was registered on the dial near the dome." This is merely the newspaper's own peculiar way of paraphrasing a simple statement in the *Astrophysical Journal* regarding the detection of a faint star near Vega. A persistent search by all the members of the staff has not yet brought to light the mysterious 'dial near the dome,' with its precious record of discovery. It seems probable that the same dial must have treasured up the remarkable observations of the Moon, which the Associated Press thought worthy of transmission to Europe, though they originated in a reporter's fertile brain, and still remain unknown to the telescope to which they were ascribed. An influential newspaper selected these latter observations as the text of an editorial setting forth the marvelous benefits the Yerkes telescope is destined to confer upon mankind.

It may be added that the great telescope of the 'Moon Hoax' is hardly more extravagant in conception than certain schemes which have been proposed in all seriousness within the past year. One of these inventors, whose familiarity with the difficulties of telescopic observation is certainly surpassed by his optimism, remarks: "I think the limit (of magnification) will be due to the shaking of the instrument caused by the trembling of the earth and of the clockwork mechanism which moves the telescope. Under these high magnifications extremely minute vibrations are so much magnified that a small object like that of a house

upon the surface of Mars would dart in and out of the field of vision so as to prevent its being photographed." And this he believes to be the only obstacle (though fortunately it is to be overcome) which can interfere with his studies of Martian architecture.

So far we have considered only what great telescopes *cannot* accomplish, and were I not to pass rapidly on to some positive statements of another character, I might be supposed to believe that they have no reason for existence, or at best are no better than small ones. But I shall endeavor to show that exactly the contrary is true; that while large telescopes do not possess the extraordinary powers conferred upon them by fertile imaginations, they nevertheless play a most important part in scientific research, and render possible many investigations which are altogether beyond the reach of smaller instruments. It seems the more necessary to dwell upon this point, for only a few years ago there appeared in print an article entitled 'Do Large Telescopes Pay?' which was evidently not written by one of those to whom reference has just been made, but by one of another class, whose known acquaintance with astronomical work would tend to give his opinion considerable weight with many intelligent readers. In discussing the subject it was seriously asked whether the great investments of money which had been made in the giant instruments of the latter half of the nineteenth century had been attended by commensurate advances in astronomical knowledge. The question is certainly one that deserves serious consideration, for it would surely be poor policy to erect great telescopes if they are no better than smaller and much cheaper ones. It is desirable, therefore, to point out, if I can, some of the elements of superiority of large instruments which seem to me to make them worth all that they cost and more.

Leaving aside reflecting telescopes, as most of the very costly instruments in use are refractors, it will be seen that our problem is, for the most part, a comparison of the properties of a large achromatic lens with those of a small one. To render the discussion more definite let us compare a 40-inch lens of 62 feet focus with a 10-inch lens of 15½ feet focus. The large lens, then, has a diameter four times that of the small one, which means that its area is sixteen times as great. It will thus receive upon its surface from a given star sixteen times as much light, and all of this will be concentrated in the point-like image of the star, except that portion which is lost in transmission through the lens. On account of its greater thickness, the large lens transmits only about 65 per cent. of the visual rays that fall on it, while the small lens transmits about 77 per cent. But after allowance has been made for the loss due to both absorption and reflection it is found that the image of a given star produced by the large telescope will be nearly fourteen times as bright as that given by the small one. In this instance all of the light is concentrated in a point, but in the case of a planet or other extended object, on account of the fact that the focal length of the telescope increases as its aperture increases, the brightness of the image is no greater with the large glass than with the small one. The image is, however, four times as large, and this has a most important bearing upon certain classes of observations, particularly in photographic and spectroscopic work.

There remains still another peculiarity of the large lens as distinguished from the small one. On account of the nature of light, the power that a lens possesses of separating two luminous points which are so close together as to be seen as a single object by the unaided eye depends directly upon its aperture. Thus, if we consider a

double star, the two components of which are separated by a distance of 0".5 of arc, it will be barely possible with a 10-inch telescope to resolve the star into two points of light just touching one another. If the members of the pair are closer than this they cannot be separated with a 10-inch glass, no matter what magnifying power is used. With a 40-inch telescope, on the other hand, it is not only a simple matter to separate stars 0".5 apart, but it is even possible to distinguish as two points of light the components of a double star of only 0".12 separation.

To sum up, then, we see that the principal advantages of a 40-inch object-glass as compared with one of 10 inches aperture are: first, its power of giving much brighter star images, and thus of rendering visible faint stars which cannot be seen with the smaller telescope; second, the fact that it gives at its focus an image of any object, other than a star, four times as large as the image given by a lens of one-fourth its aperture and focal length; and third, its capacity of rendering visible as separate objects the components of very close double stars or minute markings upon the surface of a planet or satellite. Mention should be made here of the fact that the large glass assuredly has some disadvantages as compared with the smaller one, particularly in that it requires better atmospheric conditions to bring out its full qualities. But I think it will be seen from what follows that these disadvantages are by no means sufficient to offset the great advantages possessed by the larger instrument. Let us now consider what practical benefit the astronomer enjoys from the special properties of large lenses which have just been enumerated.

Like other scientific men, astronomers who expect to accomplish much of importance at the present day find it necessary to specialize, and to devote their attention to certain classes of work in which long study and experience have given them particular skill. Thus it is that to some astronomers certain of the advantages of a large telescope appeal much more strongly than do others. In fact, in order to derive the best results from the use of the instrument it is necessary to have observations made with it by men who are capable of bringing out its best qualities in various kinds of investigation. Thus the first mentioned property of rendering visible faint objects should be utilized by an astronomer who has gained much experience in searching for and measuring objects at the very limit of vision. One who has not given special attention to this class of work would be surprised to see in a large telescope certain of the faint stars or satellites of whose discovery he may have read. When the fifth satellite of Jupiter was discovered at the Lick Observatory by Professor Barnard, in 1892, claims were put forward by certain amateur astronomers who possessed small telescopes that they themselves were entitled to the honor of the discovery, for they had seen the satellite long before. Such claims might be taken in earnest by one unfamiliar with the instruments employed by the respective observers. But it is only necessary to examine this minute object with a 36-inch or a 40-inch telescope in order to appreciate the great merit of the discovery and the absurdity of such claims as have been mentioned. The tiny satellite is so faint that hitherto it has been seen with very few telescopes, all of them having large apertures. In its rapid motion close to the surface of the great planet it is completely invisible to an eye unprotected from the brilliant light of Jupiter. Even the close approach of one of the other satellites is sufficient to cause it to disappear. In measuring the satellite Professor Barnard finds it necessary to reduce the light of Jupiter with a piece of

smoked mica, through which the planet is still clearly visible and easily measurable, though not annoying to the eye. Without an instrument like the Lick telescope the fifth satellite of Jupiter would never have been known. It may be interesting to mention here that Professor Barnard's recent measures of this satellite with the Yerkes telescope have shown that his original determination of the time of its revolution in its orbit, made five years ago at Mt. Hamilton, was not in error more than 0.03 seconds. It was found that the time of elongation differed less than half a minute from the time predicted in the *Nautical Almanac.* The period is now known within a few thousandths of a second. In this connection also it is well to add that Professor Asaph Hall's discovery in 1877 of the two small satellites of Mars was directly due to the advantage given him by the large aperture of the 26-inch telescope at the United States Naval Observatory.

Such small members of the solar system are by no means the only feebly luminous objects which great telescopes have brought to light. Faint stars in the close proximity of bright ones are usually beyond the reach of small telescopes. Thus the companion of Sirius was not seen until 1862, when the late Alvan G. Clark encountered it in his tests of the 18-inch objective now at the Dearborn Observatory, which was the largest glass that had been constructed up to that time. The small companion to Procyon, discovered not long ago by Professor Schaeberle with the Lick telescope, is another object of the same type. These are conspicuous examples of that great class of objects known as double stars, which consist of two stars revolving about their common center of gravity. From the third advantage of large instruments to which reference has already been made, it will be seen that they are peculiarly adapted for the investigation of these binary systems, not only because of their power to show faint objects in the neighborhood of brighter ones, but also on account of their capacity to separate two closely adjacent stars which in a smaller instrument would be seen as one. Thanks to this property, many interesting binary systems whose components are exceedingly close together have been found by Professor Burnham with the Lick telescope, and, although he has devoted no special attention to a search for such objects, Professor Barnard has already encountered several of them in his work with the Yerkes refractor. From what the spectroscope has taught us of binary systems, we have every reason to believe that telescopes may go on increasing in aperture almost indefinitely without ever arriving at the possibility of separating into their component parts all existing double stars. As has been stated, the Yerkes telescope can show as distinct objects stars which are no further apart than 0.″12 of arc, and on account of the elongation of the image a double star whose components are only 0.″1 apart can be distinguished from a single star. But there undoubtedly exist stars far closer together than this, some of which can be separated by an aperture of not less than forty feet.

There has been much discussion in recent years regarding the relative advantage of large and small telescopes for observations of the markings on planets. I do not propose to enter into the details of this discussion, partly because my own investigations are primarily concerned with observations of another nature, and thus have not especially qualified me to form an opinion on this point, and partly on account of the fact that additional arguments in favor of large instruments would serve little purpose. It seems to me only necessary for an unprejudiced person to examine a planet first with a small telescope of from five to fifteen inches aperture, and then to

look at the same object with an instrument of 36 or 40 inches aperture, under identical atmospheric conditions. When the seeing is distinctly bad, that is, when the atmosphere is in so disturbed a state that the images are blurred and unsteady, the smaller instrument will assuredly show all that can be seen with the larger one. But with better atmospheric conditions, to my eye at least, the advantage lies wholly on the side of the larger instrument, whether the object be the Moon, Jupiter, Mars or Saturn. In the case of the Moon particularly much fine detail which I have never been able to see with the 12-inch telescope is clearly and beautifully visible with the 40-inch. I am certainly inclined to think that large telescopes are greatly to be preferred to small ones for work of this character. But I give much less weight to my own opinion on this subject than to that of Professor Barnard, who for many years has observed the planets with instruments varying in size from a 5-inch telescope to the 36-inch on Mt. Hamilton and the 40-inch of the Yerkes Observatory. He believes a large aperture to be immeasurably superior to a small one for these observations. This seems to me quite sufficient to settle the question, for it would be difficult to name a better authority.

One incidental advantage of such an instrument as the 40-inch telescope, which depends to a great degree upon the stability of its mounting, is the ease and certainty with which micrometrical measures can be effected. Since the telescope was first ready for regular use last September, Professor Barnard has made with it a long series of micrometrical measures, which have included such objects as the satellite of Neptune, the companion to Procyon and the fifth satellite of Jupiter. The precision of these measures is most satisfactory, and lends special interest to an attempt which he has made to determine the parallax of the nebula N. G. C. 404, which is in the field with the bright star $\beta$ Andromedæ. This object has a definite condensation, which permits its position to be accurately determined with reference to a number of stars in the neighborhood. A long series of measures, covering a period of five months, have led to the conclusion that the nebula cannot possess a parallax as great as half a second of arc, and, therefore, cannot be nearer the Earth than about four hundred thousand times the distance from the Earth to the Sun.

Mention should be made of one more interesting observation by Professor Barnard, which would have been much more difficult with a small telescope. It will be remembered that in the valuable work which Professor Bailey has been doing at the station of the Harvard College Observatory in Arequipa, Peru, excellent photographs were obtained of southern star clusters, which show that these clusters contain an extraordinary number of variable stars. Not only do scores of stars in a single cluster vary in their light, but the change is exceedingly rapid, occupying in some instances only a few hours. So far as I know, none of these remarkable variations had been seen visually until Professor Barnard undertook the systematic observation of one of the clusters with the 40-inch telescope. On account of the large scale of the images, he is able to distinctly see stars in the cluster without confusing them with others in their neighborhood, and has thus been enabled to follow their changes in brightness. In this way he has confirmed the variability of many of the stars on Mr. Bailey's photographs. There are few more remarkable objects in the heavens than these magnificent star clusters, so many members of which are subject to fluctuation in their light. Professor Bailey's discovery is the more note-

worthy considering the fact that such an object as the great cluster in Hercules contains not more than two or three variable stars, while the Harvard plates show that the cluster Messier 3 contains 132 variables. This is only one instance out of many of the striking efficiency of the photographic work which is being carried on under Professor Pickering's able direction.

It may be well to introduce here a few words regarding the magnifying powers employed in actual observations. The optimistic writer, who is planning to photograph houses on Mars, believes that his recent invention will render possible the use of powers as high as a million diameters, and even greater, so that if men exist upon the planets they can easily be seen. Astronomers know nothing of such powers in practice. For double-star observations, with the largest telescope and under the most perfect conditions, powers as high as 3,700 diameters have occasionally been used. But in regular work it is not a common thing to exceed 2,700 diameters. Under very exceptional circumstances the Moon might perhaps be well seen when magnified 2,000 diameters, but this would be an extreme case, and in general a much better view could be had with powers ranging from 500 to 1,000. Jupiter can rarely be well seen with a power greater than four or five hundred, though Saturn will stand considerably higher magnification. Mars is best seen with a power of five or six hundred. With small telescopes lower powers are generally used. The difficulty is not in finding optical means to increase the magnification, as some of these newspaper writers seem to imagine. It is rather a question of being able to see anything but a confused luminous object after the high eyepieces have been applied. The more or less disturbed condition of the Earth's atmosphere is mainly responsible for this, but it is doubtful whether, with even perfect conditions, such an object as Jupiter could be advantageously submitted to great magnification.

During the present century there has grown up side by side with astronomy, to which it in fact owes its existence, the new science of astrophysics. In a broad sense this science may properly be classed as a department of astronomy, but at the present time its interests are so manifold, its methods so distinct, and its relationship to pure physics so pronounced, that it may fairly claim to be considered by itself as a coordinate branch of science. While astronomy deals more especially with the positions and motions of the heavenly bodies, it is the province of astrophysics to inquire into their nature and to search out the causes for the peculiar celestial phenomena which the special instruments at the disposal of the astrophysicist bring to light. It should be added that no hard and fast line can be drawn between astronomy and astrophysics, as one of the principal problems of the latter subject involves just such determinations of motion as are particularly to be desired for the purposes of the astronomy of position. The subjects are thus intimately related and closely bound together, and the bond between astrophysics and physics is hardly less strong. They should thus be cultivated together, so that they may mutually assist one another in bringing about the solution of the varied problems with which they are concerned.

It is particularly in astrophysical research that a great telescope is advantageous. For the principal instrument of the astrophysicist, the spectroscope, it is necessary to have as much light as can be gathered into a single point. With sufficient light the chemical analysis of the most distant star resolves itself into a comparatively simple problem. But with small telescopes and consequently faint star images such analysis, except of a roughly approximate

character, is impossible with the less brilliant stars.

One of the principal problems of the astrophysicist is to determine the course of celestial evolution. It has been found that the spectra of stars are susceptible of classification in a few well defined types, which seem to correspond with different periods in stellar development. Starting from the great cloud-like masses of the nebulæ, it is supposed that stars begin to form in regions of condensation, and that the great masses of gas and vapor continue to contract under the action of gravitation, meanwhile radiating heat into space. It is known from theoretical investigations that such cooling gaseous masses not only continue to grow smaller; they also rise in temperature with the advance of time. Finally a certain point in their career is reached when the rise in temperature ceases, though the contraction of the mass is not arrested. The balls of condensing vapors continue to cool, losing more and more heat, and becoming smaller and smaller in diameter. It is perhaps at about this period in their history that they pass through such a stage as is now exemplified by the Sun, which has presumably cooled from the condition of a white star like Sirius to that of a star of the second or yellow class. The spectra of such hot stars as Sirius contain little more than dark and exceedingly broad lines, grouped in rythmical order and due to the gas hydrogen. As these bodies continue to cool the strong lines of hydrogen become less prominent, and lines due to metallic substances begin to appear. These become more and more striking, until finally we reach such a type of spectrum as that of Procyon, which is intermediate in character between the Sirian and the solar stars. From this point on we find a continual approach to the solar type, until at last stars are reached whose spectra agree line for line with that of the Sun. After passing through the condition of the central body of the solar system the yellow and orange color of the stars becomes more pronounced, and subsequently a reddish tinge appears, until finally stars of a deep red color are found, which seem to mark the last stage of development before complete extinction of light. Through a part of this line of evolution it is easy to trace the changes in stellar spectra, the solar lines still continuing to be present, and superposed upon them a remarkable series of flutings which are characteristic of these reddish stars of the third class. But between such stars and those of the class which Vogel has designated as IIIb there seems to be a break in the evolutionary chain.

Stars of Class IIIb are of an orange or red color, and with the telescope alone some of them cannot be distinguished in appearance from the more fully developed stars of Class IIIa. But in the spectroscope they are entirely different. All of these objects are extremely faint, the two brightest of them being hardly visible to the naked eye. For this reason but little has been learned of their spectra, although the spectra of stars like Vega and Arcturus, which are some scores of times more brilliant, have been carefully investigated by both visual and photographic means. According to Dunér and others, the spectrum of the star known as 152 Schjellerup consists of certain heavy, dark bands, which coincide closely in position with bands given by compounds of carbon, and, in addition to these, a luminous zone in the orange portion of the spectrum. Three or four of the most intense solar lines have also been detected in these objects. But beyond this it is impossible to go with the appliances used in the earlier investigations, although it may well be that photographic methods would have greatly changed the character of the results obtained.

During the past winter a photograph-

ic study of the red stars has been rendered possible by the 40-inch Yerkes telescope. Photographs of the spectra of many objects of this class have now been obtained, and many lines which were not previously recognized on account of the faintness of the spectrum in small telescopes have been recorded. In the case of two stars of Class IIIb, 132 and 152 Schjellerup, the spectra have been photographed with a powerful spectrograph containing three prisms, giving high dispersion and considerable precision to the measures. It has been found that among the most characteristic features of these spectra are numerous bright lines, some of which seem to have been glimpsed by Secchi in his pioneer work at the Collegio Romano, though his drawings do not correctly represent their appearance or position. In fact, he recorded bright lines where none exist, and failed to record others, among which are the brightest in the spectra. Both Dunér and Vogel, who are certainly to be regarded as the best authorities on the subject, altogether deny the presence of bright lines. And had my own observations been confined to an examination of the spectra with the instruments used by these observers I would unhesitatingly subscribe to their opinion. But the great light-collecting power of the 40-inch telescope renders the detection of the bright lines a comparatively easy matter. Even with this instrument, visual observations with the low dispersion spectroscopes used by Dunér and Vogel would hardly show them, but they are easily seen with a three-prism spectroscope, and they have been repeatedly photographed with one and with three prisms. Some of these photographs have been measured and the wave-lengths of the bright and dark lines determined. A comparison of the results with those obtained for other types of stellar spectra suggests certain interesting relationships, which, if confirmed by subsequent work, will be of service in tracing the course of stellar evolution.

This is only a single instance of the advantages for stellar spectroscopic work of the great light-collecting power of large telescopes, but it would be easy to multiply examples. Our knowledge of the peculiar spectra of the stars of the Wolf-Rayet class, all of which are found in the Milky Way or its branches, is due in large part to the visual and photographic study of these faint objects made by Professor Campbell with the Lick telescope. In the able hands of Professor Keeler, whose recent election to the directorship of the Lick Observatory is so truly a cause for congratulation, the same powerful instrument rendered possible the determination of the motion in the line of sight of the planetary nebulæ. We may well be confident that the future record of the great telescope on Mt. Hamilton will be marked by many similar advances.

I might profitably go on to speak of the advantages of large telescopes for the study of the Sun, for in no field of research can they be better employed. In photographing the solar faculæ with the spectroheliograph the large image given by a great telescope is particularly useful for purposes of measurement, as well as for the study of the form and distribution of these phenomena. Prominences, too, whether of the quiescent or eruptive class, are best photographed on a large scale. With a large image it may also become possible, under good atmospheric conditions, to photograph some of the delicate details in the chromosphere, which, with a small solar image, would be wholly beyond the reach of the photographic method. It is probably in the study of the spectrum of the chromosphere, however, that one best perceives the advantage of a large instrument as compared with a small one. Recent experience has made this very clearly evident, for with the 40-inch Yerkes telescope

it has been possible to see in the chromospheric spectrum a great number of faint bright lines which were wholly beyond the reach of the 12-inch telescope used in my previous investigations. In this way it has been found that carbon vapor exists in the vaporous sea which covers the brilliant surface of the photosphere.

It will be admitted, I think, from what has been said, that great telescopes really have a mission to perform. While, on the one hand, they are not endowed with the almost miraculous gifts which imaginative persons would place to their credit, they do possess properties which render them much superior to smaller instruments and well worth all the expenditure their construction has involved. In answering the question: 'Do large telescopes pay?' it is simply a matter of determining whether the work which cannot be done without the aid of such telescopes is really worth doing. No one who is familiar with this work is likely to deny that it is worth all the money and time and labor that can be devoted to it. I therefore confidently believe that the generous benefactions which during the last quarter century have permitted the erection of large telescopes in various parts of the world have been wisely directed, and that further sums might well be expended, particularly in the southern hemisphere, in the establishment of still more powerful instruments.

GEORGE E. HALE.

---

## *JULIUS SACHS.**

AFTER great suffering, Julius Sachs sank peacefully to rest at six o'clock on the morning of the 29th May, 1897, at Würzburg, the scene for many years of his labors. Wherever scientific botany has a home, and by many outside the narrow circle of specialists, this loss has been regarded as irreparable. By no one has it been felt more keenly than by the writer of these lines, who will always thankfully recall the happiness it has been to him to have been closely connected throughout a long series of years as pupil and friend with him who has passed from our midst.

When I attempt to briefly sketch the life of the man to whose brilliant intellect botany is so greatly indebted, there rises involuntarily to my mind the saying of Petrarch's:

Si quis tota die currens
Pervenit ad vesperam satis est.

Yes, his life was a struggle, a ceaseless, single-minded pressing forward without rest to the goal of knowledge. To him study, research, teaching, were not merely the external activities of his calling that might be laid aside for hours, days or even weeks, and then be again resumed. They absorbed his whole being more than was good for his personal welfare. But the evening came after this long day in which he had so faithfully labored. No one realized this more fully than he himself. A prey to physical suffering, his sharpest pang was that he could no longer work for science with his former energy, and if anything made it hard for him to face death it was the knowledge that he must leave behind as an unfinished sketch much that he wanted to say to the world.

He had been chiefly occupied during these last years with a work which, under the title of *Principien Vegetabilischer Gestaltung* (*Principles of Vegetable Form*), was to set forth his views upon causal morphology. "I should feel it an immense grief if I were prevented from writing this book," he says. "It would embody the thought of forty years, and it is always important that one's ideas should be long and thoroughly brooded over. To finish it would render the last

* A translation for *Science Progress*, by Miss E. D. Shipley, from an article by Professor K. Goebel in *Flora*.

years of my truly miserable existence in some degree bearable." *

Sachs was essentially a 'self-made man,' who found it by no means a light matter to attain the eminence which led the most distinguished German universities each to desire to win him for itself. The story of his early years, as it appears in these pages, is taken from an autobiography intended for his own family, Fräulein M. Sachs having kindly made extracts from it for my use. It will be of great interest to many who only knew him as a mature man occupying an honorable position to learn how literally true were the words 'tota die currens.'

Sachs was born on the 2d October, 1832, at Breslau, where his father was an engraver. For a time his parents lived in the country, and this may have contributed to the early awakening of his mind to the beauty of nature, at which he always looked as much with the eye of an artist as with that of an observer. The design that he cherished at one time of writing a work on the beauties of the plant-world was unfortunately never realized. It would have been of the greatest interest if he, an adept in the art of word-painting, an enemy to all affectations and mannerisms, had given us his thoughts upon this theme.

His first experiences of school life were not pleasant. Learning by heart, that purely mechanical acquisition of knowledge, was a burden to him, as it has been to many another highly gifted scholar. Of much greater importance than his school instruction was his father's training in drawing. From his thirteenth to his sixteenth year he drew and painted flowers, fungi and other natural objects, and his artistic talents played, as we shall see later, an important *rôle* in his career.

His family possessed but few books, and the boy felt stirring within him a longing, doubtless inexplicable to himself, for intellectual advantages. And thus his brother's acquaintance with the sons of the physiologist Purkinje,* at that time a professor at Breslau, was of great importance to him. His brother brought home the *Penny Magazine* from these playfellows, and the prehistoric animals depicted in it aroused so great an interest in Julius, then as always thirsting for knowledge, that although he could not understand the English text the 'extinct monsters' appeared to him most realistically in his dreams! Later he himself came to know Purkinje's sons, and this acquaintance shed a ray of light upon his life; for the first time he saw a refined home, free from all petty cares as to daily bread, filled by stirring intellectual life, and dominated in every detail by the imposing figure of the white-haired professor who inspired Sachs with the greatest respect. Julius learned from his sisters to press plants and heard that there were such things as botanical collections; he proceeded to start one for himself. His father, who knew the popular names of many plants, encouraged these endeavors. They made expeditions in the early morning hours, and at fourteen years old Sachs could already determine his plants according to Scholtz's 'Flora.' But his herbarium was stolen, and this was his first bitter, deeply felt grief. He related his loss to every one and could not understand that other people failed to recognize its gravity. He never again collected plants until in later years, as professor, he started an herbarium for the purposes of demonstration. The way in which at the present day so many botanists entirely neglect the practical knowledge of plants was

* The quotations are principally taken from letters.

* J. E. Purkinje (1787–1869) was professor of physiology and pathology in Breslau from 1823 till 1850, and afterwards in Prague. He was the author also of a botanical treatise (*De cellulis antherarum fibrosis nec non granorum pollinarium formis commentatio phytotomica*, Breslau, 1830).

wholly distasteful to him, as the following remark in one of his letters shows: "I strongly disprove of the so-called 'physiologists,' to whom the commonest meadow and garden flowers are unknown, especially as such people generally have but little knowledge of physics." And if he complained many a time in joke of the foolishly unnecessary and tedious multiplication of phanerogamic varieties he was far from undervaluing the knowledge and study of them. Indeed we shall come across instances of the keen interest in the common problems of systematic botany which constantly appears in his writings.

It was his mother who conceived the thought of allowing him to attend the gymnasium, a privilege accorded to none of his brothers, for this considering the family poverty involved no slight risk.

The years he spent at the Elizabeth gymnasium formed a bright picture in Sachs' life. The school work was congenial to him; it lifted him out of the petty surroundings of his home-life into a higher sphere. He attended the gymnasium from 1845 to 1850. Of the masters only one—Dr. Rumpelt—came at all into personal contact with him. He recognized Sachs' exceptional talents and the two became good friends. On the other hand, the natural science master, the lichenologist Körber, only repelled him. Körber could not instruct and had no conception how to impart anything worth knowing about his subject. Sachs, therefore, worked on at his scientific pursuits unaided and undirected. He read eagerly, without its doing him any harm, Oken's 'Philosophy of Nature,' which he had bought at a sale for a few pence, began to make a collection of skulls, and wrote a monograph on the crayfish. Körber's attention was drawn to this work by Dr. Rumpelt; he sent for Sachs and solemnly warned him against devoting himself to natural science, on the ground that it would not bring him in a half-penny! One cannot but rejoice that this advice was not acted upon.

In the year 1848 Sachs lost his father, and in the following year his mother. Thus orphaned, he lived at first with his brother, where, to his great joy, he was alloted a room in the roof which, otherwise unattractive, afforded him the opportunity of carrying on his scientific studies in his scanty leisure. Here, for instance, he mastered the Latin Anatomy of Bartholinus. It became more and more imperative, however, that he should face his position. He left the school (having risen to the upper second form) and wished to go to sea.

In the meantime Purkinje had been called to Prague. He remembered his son's friend and wrote suggesting that Sachs should come to him as a kind of private assistant. He was to prepare natural science drawings and in return to receive the modest salary of 100 florins a year and his keep.

After numerous difficulties with his guardians, Sachs left Breslau on the 14th of February, 1851, for Prague. He found there shelter, it is true, but no home. Purkinje was a man of high attainments, for whose genius Sachs had great respect. But their peculiar temperaments made it impossible for them to understand each other, and the elder naturalist had no word of recognition, sympathy or encouragement for the younger. He was of peasant origin and this stuck to him all his life. Sachs, on the other hand, felt himself—as he said with reason, in spite of the reduced circumstances of his family—to be a born aristocrat, and so there could not fail to be friction between them.

Whilst Sachs was at Prague the question arose whether he should remain simply an illustrator of scientific writings or should carry on his studies further. Fortunately, he decided upon the latter course, and, despite the time that had elapsed since he left

school, successfully passed his matriculations at Prague in the autumn of 1851 with a view to entering that university.

The young student was already too independent and critical to be an ardent frequenter of the lecture room, where it would have required a man of exceptional ability to have secured his attendance, and it was evident that there were at that time but very few such men at the University of Prague. Botany was represented by Kosteletzky, who was lecturing upon Schleiden's works. Sachs attended two or three lectures and then stayed away; the truth was that he needed no teaching on this subject. He paid special attention to chemistry, physics and mathematics. But the only man who attracted and helped him on was Robert Zimmermann,* who invited him to his house. "I went to him with an inclination towards philosophy, but he directed me into the right way," Sachs says, speaking of Zimmermann; "he and my earlier teacher, Rumpelt, are the only two who gave me any real help; apart from their aid I am self-taught." He read a good deal of philosophy after he had become acquainted with Zimmermann—Herbart, Leibnitz, Kant, Locke, Hume and even the Schoolmen. At the same time he was privately working at zoology and botany, and for several years paid special attention to physics and mathematics. In 1856 he was made Doctor of Philosophy, a degree which at that time was hard to obtain at Prague. His outward circumstances, since he had separated from Purkinje, remained precarious; he earned small sums by literary work, drawings of fossils, etc., and at this time made his first experiments in the physiology of plants. In 1857 he was made privat-docent in plant physiology. Up to that time this had not been a recognized subject and there were various difficulties to overcome. "Two lectures are ample for all there is to say upon the physiology of plants," said Rochleder, the chemist, and at that time he was not so very far wrong.

Sachs, who later was certainly the best teacher that the new botany has produced, was by no means a success as privat-docent. One reason for this may be that he took but slight interest in the art of teaching. He lived wholly for science and was beyond measure studious; "it engrossed my thoughts even when I was out walking," he says. This being so, it came to him, according to his own account, more or less as a revelation that what he had to do was not only to acquire as much knowledge as possible, but also to produce some original work. From that time he only sought to work out his own ideas, to attain his own aims. He became acquainted with several of the chief exponents of botany of the day, such as Unger, Nägeli and Alexander Braun, all of whom he met at the Natural Science Congress in 1856 at Vienna; and also about 1857 with Hofmeister who, in the intercourse that lasted between them for many years, influenced Sachs strongly, though, as the latter considered, at times in such a way as to perplex him.

In the meanwhile he was finding his life in Prague almost unbearable. The patriotic Czechs of the National party opposed him as a German, and openly told him that they wanted to drive him away. Whilst this was going on, the attention of Professor Stein, the well-known zoologist, had been directed to Sachs. Stein had formerly devoted some of his time and energy to the Academy of Forestry at Tharandt and introduced Sachs to the chemist Stöckhardt, the director of this institution. Sachs was invited to draw up a statement as to the relation of plant-physiology to agriculture, with the result that he was called to Tha-

*Robert A. Zimmermann, born at Prague, in 1824, studied philosophy, mathematics and natural science, became professor of philosophy at Prague in 1852, and since 1861 has held the same chair at Vienna.

randt as physiological assistant in 1859. He went there in the March of that year. His chief work here was to show that land plants could be raised in aqueous solutions of nutrient salts, but he was busy at the same time with other physiological experiments. 'Die Entdeckungen lagen damals am Wege' was his opinion, 'die Botaniker trieben andere Dinge.' Even then Nägeli, for instance, described Sachs' researches as belonging to the chemistry of agriculture; there was as yet no talk in Germany of the chemistry of plant-physiology.

In summer he started work at four o'clock in the morning, and by so doing found time during the years 1859 and 1860 to study the earlier plant physiologists besides doing his own work. These literary studies caused him, in 1860, to suggest to Hofmeister that they should edit a large hand-book of botany, in which the collected results of what we now call 'general' botany should be critically set forth. The *Handbuch der physiologischen Botanik* remains, as is well known, a fragment; various collaborators who had undertaken certain parts drew back, and Hofmeister fell ill and died in 1877 without being able to complete his share; but in spite of all mishaps the four volumes that appeared rank among the most valuable productions of more recent botanical literature. Sachs had frequently to give addresses at agricultural meetings and so gained the useful knowledge that he had a natural gift for public speaking.

In the winter of 1860–61 he was invited to become the head of the recently established agricultural department of the polytechnic at Chemnitz. His position there bristled with difficulties, and he welcomed the proposal that he should accept the chair of botany and natural history at Poppelsdorf, near Bonn, whither he removed in 1861. Here he married and in time became the father of two daughters and a son.

As regards science the six years spent at Bonn are among his most fruitful. Besides a number of other works, it was here that his 'Experimental Physiology' was written and the 'Text-book' begun. His lectures were highly appreciated, and at the end of two years he was relieved from lecturing upon mineralogy and zoology; henceforward he dealt only with physiology during the winter, and in the summer delivered special lectures on agricultural plants. There was but little intercourse between him and the botanist Schacht, who was then at Bonn, but who was already in bad health, and whose temperament was thoroughly uncongenial to his own. With Schacht's successor, Hanstein, on the contrary, friendly relations ensued. On New Year's Eve, 1866, he received the news that he had been called to Freiburg im Breisgau as successor to De Bary; he went there in April, 1867. A small salary and a poor garden formed two undesirable elements in his life at Freiburg, and after three terms he willingly left to go to Würzburg. There, as we know, he remained, in spite of brilliant offers to move elsewhere. As early as 1869 he received a call to Jena, in 1872 to Heidelberg, in 1873 to Vienna, in 1877 to Berlin, where later they tried to obtan him for the Agricultural College; he was also invited to Bonn under tempting circumstances. When Nägeli retired, the professorial chair at Munich was offered him. It is much to be regretted that he did not accept one of these invitations whilst his health was still good, especially as the climate of Würzburg is hardly favorable to nervous constitutions. It may, perhaps, have been the needs of his family, which pressed heavily upon him, or attachment to all he had acquired at Würzburg and dislike to the loss of time and strength inseparable from each change of place, that kept him there. The government testified its appreciation by investing

him with titles and orders; as early as the autumn of 1871 his colleagues chose him for their rector, and he was repeatedly elected to the Senate.

With the commencement of his professional life at Würzburg, Sachs' 'Wanderjahre' came to an end. They had been, as the preceding facts show, beset with difficulties. "I was thirty-six years old when, with a salary of about 2,000 guldens, I came to Würzburg and found a hole in which to hide my head. During the three previous years, in which I had laid aside the 'Experimental Physiology' and had been writing the 'Text-book,' I had had a severe struggle, in the strictest sense of the word, to provide for the wants of my family. I was thirty-seven years old when I succeeded for the first time in investing 200 thalers in the public funds, and had for twenty years daily worked from fourteen to fifteen hours. As you see, my life has not been an easy one, and yet I wish that things went as well with me now as they did then, for what I have been through since is truly more than a man can bear."

The strong expression that he uses in speaking of the laboratory at Würzburg shows that there was much to be desired both in it and in the gardens attached to it. The laboratory which under his direction obtained a world-wide reputation and attracted young botanists from all parts was housed, together with the clinical schools and the Institute of Pharmacology, in a building that contrasts most modestly with the handsome modern structures that have arisen in many universities. And yet how much he accomplished in it! Little by little the whole of it came to be given up to botanical purposes, Sachs being much too modest to insist on a new botanical laboratory in spite of the fine new buildings that were erected for the other sciences. He contented himself with the addition of a very beautiful and suitable lecture-room. He was particularly anxious about the garden, which was laid out on barren soil made up chiefly out of the rubbish-heap of an old fortress. He gave it his own personal and devoted attention, and was rewarded by a luxuriant vegetation where formerly there had been but a barren waste. Later on he divided off a small part of the garden for special purposes, and this he attended to himself with the help of his laboratory servant. There he made open-air experiments, and there also was the well-known *Schilderhaus* (sentry-box) for experiments in etiolation, etc. The cultivation of strong, healthy plants for the purposes of investigation was in his opinion an essential part of experimental physiological work; he excelled in the art and deemed it worthy of individual, personal attention. There were almost invariably plants growing in his work-room, but in the summer time, when growth was going on in the plant-world, it was essential to him to make constant observations out of doors and to meditate upon his investigations as he strolled about the garden.

The astonishing amount of work that he managed to get through from his earliest days could not but affect his constitution. He said himself that he had paid for each of his books with wearisome ill-health, and even the strongest nerves could not stand such ceaseless labor. Added to this came his wife's long tedious illness which undoubtedly helped to undermine his strength.

Bearing these facts in mind, it is perhaps more possible to form a just estimate of his relations with the outer world. The latter part of his life found him a lonely man who had estranged many of his friends by bitter and sometimes even unjust criticisms. We shall perhaps condone his trenchant animadversions upon the botanical writings of his day if we remember how his sensitive, highly strung temperment must have suffered at times from the irritation of private

affairs. And then again, science represented to him all that is highest in life, and it followed that any work which he considered bad from a scientific point of view seemed to him a crime. More than this, much that appeared of great importance to others had no weight with one who regarded the mission of science from so high a standpoint and whose refined nature could not fail to despise all ambiguity, empty phrases and affectations in its literature. He considered the great defect in this to be that, whilst each isolated investigation is deemed a personal achievement and quoted as such, important generalizations were regarded as impersonal property. He was by no means a man who could not endure contradiction and was always ready to listen to it when well founded; it was only when the opposition seemed to rise from incapacity and stupidity that he was roused to fierce anger. His standpoint is best described in the following words written to a friend at the end of a keen discussion: "After all, in science, as in ordinary life, all hinges upon whether a man accept the general point of view of his opponent; when that is done it is always possible to arrive at some satisfactory conclusion, and I hope this will always be the case with us."

Although the purely intellectual side of his nature outweighed the emotional, he was invariably grateful for the smallest services, and to me he always proved an indulgent, lovable teacher. At the same time he could coldly repel all who were uncongenial to him. He agreed with Goethe, 'Sage nur von deinen Feinden, warum willst du gar nicht wissen,' etc.

As time went on he became more and more dissatisfied with the state of botanical literature. Such dissatisfaction, however, did not keep him from incessant toil whenever he was well enough, and more especially when the sun shone. Like Goethe and many other sensitive natures, he was strongly affected by sunshine or the lack of it. "If you imagine yourself transplanted from Java to Bavaria and that the sun's face has been veiled for the last three weeks by a layer of sail-cloth 100 meters thick, you may form some conception of the vegetation in our garden. The grass and leaves grow as though this were a dairy-farm! Every one is charmed with our luxuriant vegetation, but there are no signs of blossoms. It is as dark at four o'clock as it would be at the same hour at Christmas, and it has been like this for the last three weeks. I should not complain, liking as I do to take things as they come, but unfortunately I cannot live without sunshine and the lack of it makes me ill."

(*To be concluded.*)

## *CURRENT NOTES ON ANTHROPOLOGY.*

### THE 'MONUMENTAL RECORDS.'

A PERIODICAL recently started in New York City should be mentioned in these notes. It is entitled *Monumental Records* and is edited by the Rev. Henry Mason Baum. As its title indicates, it is concerned with the discovery of ancient monuments, including those of both the Old and New Worlds. In the three numbers which have already appeared there are descriptions of the ruins in Yucatan and Mexico by Mr. Marshall H. Saville, translations of the Moabite stone, descriptions of the remarkable exhumation of Greek manuscripts in Egypt, a report of Mr. de Morgan's work in the same country and a running series of archæological and literary notes by the editor.

The subscription price for this handsomely illustrated periodical is placed at the moderate sum of $1.50 a year and the address is 'Box 1839, New York City.'

### THE PASSAMAQUODDY WAMPUM RECORD.

IN the *Proceedings* of the American Philosophical Society for December, 1897,

Professor J. Dyneley Prince has a most interesting article on the wampum records which have been preserved among the Passamaquoddy Indians. These symbols were rendered to him in the native dialect by a chief of the tribe, and this text is given, together with a translation into English. The method of memorizing is stated to have been that certain combinations of the shell beads suggested certain sentences or ideas. There were different varieties, the one referring to marriage ceremonies, another to funerals, to installations and the like. Examples of several of these are supplied.

It does not seem that wampum-belts were in use and Professor Prince did not find the strings themselves. His article is one of peculiar value on the still obscure subject of the uses of wampum and the manner in which it served mnemonic purposes.

THE SIGNIFICANCE OF THE SCALP-LOCK.

THE last number of the *Journal* of the Anthropological Institute contains an article by Miss Alice C. Fletcher on the significance of the tuft of hair or scalp-lock so common among the American Indians. It is drawn from her study of the Omaha tribe and their religious ceremonies. One of the most solemn of these is that of the first cutting of the hair of the children. The meaning of this rite was some sort of a consecration of the child to the God of Thunder, who was spoken of as 'grandfather.' The sign of the consecration was the small lock of hair left on the crown of the head and separately braided. It symbolically represented the life of the man, and from this arose the custom of scalping the enemy who was slain in battle, as his life thus passed into the power of his conqueror.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

## *CURRENT NOTES ON BOTANY.*

THE MORPHOLOGY OF GINKGO.

THE morphology of the Ginkgo has puzzled botanists not a little, although on account of its oddity the tree has been studied by a good many investigators. Every botanist is familiar with the naked stalks usually bearing two ovules at the summit, which have been regarded quite generally as axial in nature. This is the view held by Eichler in *Die Natürlichen Pflanzenfamilien* in 1887, and the genus is assigned to a place in the Coniferae in accordance therewith. Essentially the same view was held by Sachs in his 'Text-Book,' Goebel in his 'Outlines of Classification and Special Morphology of Plants,' Strasburger in 'Coniferen und Gnetaceen,' as well as by systematic botanists generally. On the other hand, Van Tieghem in his 'Traité de Botanique' (1891) regarded the ovule-bearing stalks as foliar in nature. In a footnote in my 'Botany for High Schools and Colleges' (1880) I wrote as follows: "The morphology of the flowers of Ginkgo, as here given, is by no means satisfactory. Instead of the ovules being borne upon naked axes, it is probable that they are in reality upon foliar organs, *i. e.*, either upon modified leaves somewhat as in Cycas, or upon elongated homologues of the 'scales' of Abies. Either interpretation would necessitate a considerable change in the systematic arrangement of Taxineæ."

In the *Botanical Magazine* (of Tokyo) for February and March, 1896, Kenjiro Fujii began a discussion of the views held regarding the morphology of the flowers of Ginkgo, and completes his paper nine months later by publishing the third installment in the number for December, 1896. The paper is accompanied by a plate in which the foliar nature of the ovule-bearing stalks is proved with the greatest certainty. All gradations are shown from the slightly modified leaf, through leaves

having a pretty well developed blade and bearing one or two ovules, to the usual naked stalk bearing one or two ovules. An examination of this plate is conclusive as to the foliar nature of the structure bearing the ovules. The homology of these structures with the ovuliferous leaves of Cycas is quite evident.

The anthers, which are born in catkin-like clusters, are shown by the same writer to be borne upon much modified leaves. The so-called 'staminate catkin' is, therefore, a single stamen bearing many anthers, reminding us again of cycas, in which, however, the antheriferous leaves are broad and the anthers sessile.

### THE RE-ARRANGEMENT OF THE GYMNOSPERMS.

THE 'considerable change in the systematic arrangement of Taxineæ,' referred to above, came very shortly after the publication of Fujii's paper, aided very greatly by Hirase's discovery of antherozoids in Ginkgo, and Ikeno's almost simultaneous discovery of antherozoids in Cycas, also. In the first Lieferung of the 'Nachtrag zu Teil, II.–IV.,' of the *Pflanzenfamilien* (1897) Engler suggests a new classification of gymnosperms as follows:

GYMNOSPERMÆ.

CLASS CYCADALES, fecundation by spermatozoids.
CLASS BENNETTITALES.
CLASS CORDAITALES.
CLASS GINKGOALES, fecundation by spermatozoids.
CLASS CONIFERAE, fecundation by non-ciliated sperm-nuclei.
CLASS GNETALES, fecundation by non-ciliated sperm-nuclei.

In the eighth Lieferung of the 'Nachtrag' (dated October, 1897) this is further modified as follows:

GYMNOSPERMÆ.

A. Fecundation by spermatozoids.
  CLASS CYCADALES.
  CLASS BENETTITALES (extinct).
  CLASS CORDAITALES (extinct).
  CLASS GINKGOALES.
B. Fecundation by sperm-nuclei.
  a. No true perianth.
    CLASS CONIFERAE.
  b. A perianth present.
    CLASS GNETALES.

This rearrangement brings about a good deal of confusion in the chapter relating to the conifers in the *Pflanzenfamilien*. We are now asked to rearrange that text so as to divide the class (after excluding Ginkgo) into two groups, viz.: Taxaceae (including Podocarpeae, with genera *Saxegothaea*, *Microcachrys*, *Podocarpus* and *Dacrydium*, and Taxeae with genera *Phyllocladus*, *Cephalotaxus*, *Torreya* and *Taxus*) and Pinaceae (now arranged under Araucarieae, Abietineae, Taxodieae and Cupressineae). We have thus a division of Conifers into a lower family (Taxaceae) and a higher (Pinaceae), and this is the sequence we are to recognize, while in the higher family the four tribes are arranged in a descending series.

The editor of the *Pflanzenfamilien* should issue a revision of the pages of 'Teil II.,' which deal with the gymnosperms (about 130 pages) in order that at the approaching completion of the work it will not be marred by the present patchwork arrangement.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

## SCIENTIFIC NOTES AND NEWS.

### THE RECENT ECLIPSE.

AT the Royal Institution on April 29th Mr. W. H. M. Christie, the Astronomer Royal, gave a discourse on 'The Recent Eclipse.'

Mr. Christie said, according to the report in the London *Times*, that he was afraid that his account of the eclipse would be somewhat imperfect, because the reports of the various observers had not yet been published, and the information he had been able to glean as to the results obtained by the parties of American, Japanese and Italian observers was somewhat meager. After the failure from bad weather, which was the fate of nearly all the expeditions in the eclipse of 1896, it was felt that every ef-

fort should be made to occupy as many stations as practicable along the track of the last eclipse, which, starting from Equatorial Africa, crossed India and ended in the Chinese Empire. It was not, however, found possible to send an observing party to Africa; so the field was narrowed to the shadow track through central India. There the choice of stations was practically confined to the neighborhood of the places where the various railway lines intersected the central line of the shadow, and of these the more westerly had the advantage of giving slightly longer duration of totality. The Joint Eclipse Committee arranged for four parties of observers. Sir Norman Lockyer, whose main equipment consisted of prismatic cameras, was at Viziadrug; Professor Turner and the lecturer, who originally intended to station themselves at Karad, near Poona, were obliged, on account of the outbreak of the plague, to go instead to Sahdol, a place farther east with a shorter duration of totality; Captain Hills and Mr. Newall were at Palgaon with slit spectroscopes, and Dr. Copeland took large-scale photographs of the corona with a lens of 40ft. focus. In addition there was a party, under the auspices of the British Astronomical Association, at Talni, consisting of Mr. and Mrs. Maunder, Mr. Thwaites and Mr. Evershed; the Viceroy of India was in the neighborhood of Buxar, near Benares, with a large party which included Mr. Pope, of the Indian Survey, and there were three other parties of observers near Jeur, to the southeast of Poona. The track of the shadow was thus very well occupied throughout India. Admirable arrangements were made by the Government for the observers, who were also indebted to the Indian railway companies for their liberal treatment. Mr. Christie then passed on to consider some of the results obtained. Beginning with photographs of the corona, he said that a special feature was the number and variety of instruments utilized to take these on the large scale of about 4in. to the sun's diameter. Professor Campbell, Dr. Copeland and Mr. Michie Smith had each a telescope 40ft. long, the form of mounting being different in each case. The instrument he himself used was on a different principle, the large scale being obtained by applying a concave lens to magnify the image formed by an object glass of comparatively short focal length. Thus the total length of the telescope was kept within manageable dimensions—11ft. in his case instead of 40ft. as in the ordinary form. Another important feature in the instrumental equipment was the coelostat—a form of mounting a mirror devised by Mr. G. Lippmann in 1895, and successfully used in the recent eclipse at three stations—Sahdol, Palgaon and Viziadrug. Another interesting new departure was Professor Burckhalter's device for giving to each part of the corona the exact exposure best suited to its brightness. He arranged to get the whole on one plate by using a slit of peculiar form in a metal screen which rotated rapidly in front of the photographic plate. Numerous spectroscopic observations were carried out both with slit spectroscopes and prismatic cameras, and Mr. Newall attempted to determine the relative motion in the line of sight by the displacement of the corona lines in the spectrum. Professor Turner made polariscopic observations to discover how much of the light of the corona was polarized, and Mr. Newall noticed strong polarization of the atmosphere at all points within 30 minutes of the sun. At Sahdol temperature observations were made, and a fall of 8 degrees was registered 20 minutes after totality. At Buxar a kinematograph was employed, but the film had since disappeared. In conclusion, Mr. Christie, remarking that the form of the corona was not quite what was expected, said that in this connection it was a suggestive fact that at the time of the eclipse there were more spots than usual on the sun at that epoch of the cycle, and that from January 15th to January 21st great magnetic disturbances were registered at Greenwich. The lecture was illustrated with many lantern slides, and a number of photographs were displayed in the library.

### THE BENEKE PRIZES.

THE Philosophical Faculty of the Georg-Augustus University of Göttingen has just published, according to *Nature*, the following information concerning the Beneke prizes for the years 1897 and 1901: On March 11, 1898, the birthday of Carl Gustav Beneke the founder of

this prize, it was announced that no communication had been sent in for the prize competition for the year 1897. At the same time the Philosophical Faculty set the following problem for the year 1901: The principle of continuity, or, more exactly, the representations by functions which can be indefinitely differentiated, has for a long time been regarded as a general valid foundation for the mathematical treatment of natural phenomena. Such a groundwork as this was quite naturally introduced by the discoverers of the differential and integral calculus. More recently, however, the progress of mathematical investigation has shown generally that this is founded on a great number of implicit suppositions to which we, in consequence of the inaccuracies of our sensitive perceptions, are not bound. Further, the assumption of the molecular constitution of matter is from the first in contradiction with well-known laws. The Faculty wishes to receive a work of real scientific interest in which such questions will be treated in a general intelligent way, and in which a minute examination will be made regarding the admissibility in relation to the appropriateness of the usual mode of representation. Communications may be mathematically or philosophically and psychologically inclined, and historical studies are desired but not demanded. Papers competing for this prize must be written in a modern language, and will be received by the Dekan of the Philosophical Faculty up to August 31, 1900. A motto should be written on the title-page of the work and on the outside of a sealed letter which must accompany it, containing the name, profession and address of the sender. In no other way can the name of the author be communicated. It is further requested that the address of the sender should be also written on the title-page, in case the prize should not be awarded to it. The first prize amounts to 3,400 Marks, and the second to 680 Marks. The prizes will be awarded on March 11, 1901, at a meeting of the Philosophical Faculty in Göttingen. The communications to which prizes are awarded remain the property of the authors. The prize problems, for which the competitive papers must be sent in by August 31, 1898, and August 31, 1899, will be found given in the *Königlichen Gesellschaft der Wissenschaften Geschäftl. Mittheilüngen*, 1896, S. 69, 1897, Heft. 1, S. 26.

## THE STATISTICIAN OF THE TREASURY DEPARTMENT.

THE New York *Evening Post*, of May 7th, states: Worthington C. Ford, Chief of the Bureau of Statistics in the Treasury Department, is the latest victim of the rush for office. He will retire on Monday of next week, making way for O. P. Austin, a former newspaper correspondent who made a specialty of furnishing statistical leaflets and circulars for the Republican National Committee during the last Presidential campaign. Mr. Hanna then promised him a position of importance, and he has now made his promise good, though at a heavy cost to the administration, under whom Mr. Ford had worked faithfully and as efficiently as he did under President Cleveland.

Mr. Ford is one of the most prominent statisticians in the country. He is an indefatigable worker, and has not only the statistical instincts, but the culture brought by long exercise of the art. He was chosen by Secretary Carlisle and President Cleveland from a large number of persons whose names had been mentioned to them, and wholly on the ground of personal merit and professional skill. It was one of the few appointments made wholly regardless of politics, and in the face and teeth of opposition from big Democrats, to whom Mr. Ford's sincerity of purpose, and his unqualified adhesion to true revenue reform and sound finance, irrespective of partisan or local interests, were repugnant. No fault, it is understood, has been found with his work, which has never fallen short of the highest grade. But he does not understand bending every other statistical consideration to the upbuilding of the Republican theory, and the purveyors of party patronage proved too strong for the conservative forces which have assured his retention so far.

The position from which Mr. Ford retires is under the civil-service rules, as extended by President Cleveland. To the world at large it is known as Chief of the Bureau of Statistics of the Treasury Department. In the section of

the revised statutes, however, which authorizes its creation, it appears simply as a division clerk, to be appointed by the Secretary of the Treasury, to 'superintendent of the bureau.' The question is likely to arise, therefore, how Secretary Gage is going to get Mr. Austin into the position vacated for him, as he is not now in the civil service.

One of two things may be done—either the same plan will be followed to which resort was had in the cases of Chief Clerk Michael, of the Department of State, and the late Director Smith, of the Bureau of American Republics, the appointment being temporarily made and a special examination held afterward, or advantage may be taken of the use of the term 'appoint' in the statute, and the assumption made that the power of appointment was absolutely vested in the Secretary, as distinguished from those positions of which he simply 'designates' a clerk to take charge.

### GENERAL.

THE University of St. Andrews will confer its honorary LL.D. on Professor William Osler, of Johns Hopkins University.

MR. W. H. PREECE has been elected President of the British Institution of Civil Engineers.

PROFESSOR CH. RICHET, the well known physiologist, editor of the *Revue Scientifique*, has been elected *membre titulaire* of the Paris Academy of Medicine in the room of the late M. Luys.

THE Paris Society of Anthropology offers in 1898 the Brocca prize (1,500 fr.) for a work on Somatology, and the Bertillon prize (500 fr.) for a work on Demography.

THE steamship *Belgica*, carrying the Belgian Antarctic expedition, has, it appears, grounded on an island near Cape Horn, which will prevent the expedition proceeding to the far South this year.

DR. NANSEN left London on April 23d for St. Petersburg, where the Geographical Society will hold a reception in his honor and listen to an address by him. Dr. Nansen will next proceed to Vienna to lecture before the Geographical Society of that city and receive its Hauer Medal. He will also lecture in Budapest and Pressburg.

HERR KRUPP, of Essen, who has recently made a number of gifts for educational and scientific purposes, has presented the Berlin Geographical Society with 10,000 Marks for the foundation of a gold medal to be named after Nachtigall, the African explorer, and to be given by preference for discoveries in Africa.

THE Trustees of the Missouri Botanical Garden hold their ninth annual banquet at the St. Nicholas Hotel, St. Louis, to-morrow.

THE United States Civil Service Commission announces that, on June 7, 1898, examination may be taken at any city in the United States where the Commission has a competent board of examiners to establish an eligible register for the grade of expert computer and geodesist. There is at present a vacancy in the U. S. Coast and Geodetic Survey, Treasury Department, at a salary of $2,400 per annum, which it is desired to fill. The duties of the position for which this examination will be held will be partly administrative, but principally they will be in the line of geodetic computations consequent upon the field work of the Survey. Such computations will embrace the whole subject of geodesy and allied subjects, the astronomical determination of latitude, longitude and azimuth; triangulation, magnetic, gravity, tidal, physical hydrography, leveling, deflections of the vertical, etc. The examination will consist of the subjects named below which will be weighted as follows:

| | |
|---|---|
| Ability and experience in the discussion of geodetic problems and administration of computing work | 25 |
| Publications in the line of geodesy, mathematics and astronomy | 25 |
| Positions held by the applicant in professional life | 25 |
| Answers to questions which will be furnished on examination | 25 |
| Total | 100 |

The Department states that it is desirable that applicants should not be over 35 years of age.

THERE is also a vacancy in the position of nautical expert in the U. S. Coast and Geodetic

Survey, with a salary of $1,800. The examination will be held on the same day and will cover the hydrographic work of the Survey, navigation and knowledge of the lighthouses, buoys and general geography of the Pacific Coast.

THE Academy of Natural Sciences of Philadelphia has appointed Mr. Wm. W. Jefferis special curator of the William S. Vaux collection for the current year. The following have been appointed the committee on the Hayden Memorial Geological Award: Messrs. Persifor Frazer, Angelo Heilprin, Theodore D. Rand, Benjamin Smith Lyman and J. P. Lesley. The award consists of a bronze medal and the balance of the interest arising from the endowment fund and is conferred annually for the best publication, exploration, discovery or research in the sciences of geology and paleontology, or in such particular branches thereof as may be designated. The recognition is not confined to American naturalists and has been granted as follows: 1890, James Hall; 1891, Edward D. Cope; 1892, Edward Suess; 1893, Thomas H. Huxley; 1894, Gabriel Auguste Daubrée; 1895, Karl A. von Zittel; 1896, Giovanni Capellini; 1897, A. Karpinski.

THE Geographical Society of Philadelphia held its annual meeting and reception on May 4th. Professor Angelo Heilprin, the retiring President, delivered an illustrated lecture on 'A Winter Trip to the Grand Cañon of the Colorado.' The annual election of officers resulted as follows: President, Henry G. Bryant; Vice-Presidents, Amos Bonsall, Dr. Daniel G. Brinton; Recording Secretary, Dr. Paul J. Sartain; Corresponding Secretary, Edwin S. Balch; Treasurer, Miss Mary Blakiston; Directors, Professor Angelo Heilprin, Miss E. E. Massey, George G. Mercer; Reception Committee, Miss Ida Cushman, Mrs. J. B. Lippincott, Mrs. Charles Roberts, Miss Rachel Sweatman; Excursion Committee, Miss Mary S. Holmes, Miss Maude G. Hopkins, Charles S. Welles, Dr. H. Emerson Wetherill.

AN International Committee has been formed for the purpose of collecting an endowment fund in memory of the late Edmund Drechsel, professor of physiological chemistry at the University of Berne, Professor R. H. Chittenden, of Yale University, being the American representative. As we have already stated, it is wished to mark with a memorial stone the burial place of Drechsel at Naples, and to secure a fund for the education of his sons. Contributions, which, it is hoped, will in some cases take the form of an annual contribution for five or ten years, should be sent to the '*Deutsche Depositenkasse A*,' Berlin W., Mauerstrasse, account of Professor Tschirch for the Drechsel-Endowment, or to the Treasurers of the local committee at Berne, Professor Tschirsch, dean of the faculty of medicine, or Professor Kronecker, director of the physiological institute.

MR. ALFRED V. ALLEN, of Bath, died on March 24th, at the age of 64 years. We announced recently the discontinuation of the *Journal of Microscopy and International Science*, of which Mr. Allen had been editor since 1882.

*Nature* announces the death of Dr. John Shearson Hyland, F.G.S., at the early age of thirty-two. The second son of Captain P. Hyland, of Great Crosby, he was educated at the Merchant Taylors' School, at University College, Liverpool, and subsequently at Leipzig. At the University of Leipzig he studied mineralogy and petrology under Dr. Zirkel, and took the degree of Ph.D., his thesis being entitled 'Ueber die Gesteine des Kilimandscharo und dessen Umgebung,' and published in 1888. In the same year he joined the staff of the Geological Survey, and was for three years occupied in the Irish branch in investigations on the eruptive rocks of the country. During this period he published several papers on petrological subjects and gave great promise of a brilliant career. Being of an active, enterprising nature, he relinquished the work of the microscope, and, throwing up his post on the Geological Survey, took to the more practical work of reporting on mineral resources in the United States, subsequently in British Central Africa, and finally on the treacherous west coast of Africa, where he died at Elmina on April 19th.

FROM the *Chemist and Druggist*, *Nature* quotes the following details regarding the late Dr. J. G. N. Dragendorff, for many years Director of

Pharmaceutical Institute at Dorpat, in Russia. Dr. Dragendorff was born in Rostock in 1836. After qualifying as an 'apotheker,' he studied chemistry in the Heidelberg University, which he left in 1860 to become assistant to Professor F. Schultze in the chemical laboratories of the Rostock University. In the same year he graduated as Ph.D., his thesis being on the action of phosphorus upon some carbonates and borates. In 1862 he went to St. Petersburg to take charge of the *Pharmaceutischen Zeitschrift für Russland*, as editor, and of the laboratories of the Pharmaceutical Society there. While acting in that capacity his reputation grew, and his appointment as professor of pharmacy and Director of the Pharmaceutical Institute at Dorpat in 1864 was the beginning of thirty years' work which made the Dorpat Institute famous all over the world, for Dragendorff's skill as a teacher and discoverer of talent brought students to him from all quarters. He retired to his native town in 1894, and devoted his leisure to a monumental work on medicinal plants, of which at least one part has been published. He was best known to English pharmacists through his 'Plant Analysis,' a translation of which, by his former pupil, Henry G. Greenish, was published in 1883. His work on alkaloids was, however, that by which he is most entitled to fame. The mydriatic alkaloids were his special field, and his syntheses of conine and atropine are amongst the most brilliant achievements of modern chemistry. In 1885 the Pharmaceutical Society of Great Britain conferred the third Hanbury medal upon him.

SUFFICIENT advance subscriptions have been guaranteed to encourage The Open Court Publishing Company in proceeding with its plan of publishing the series of large-sized portraits of philosophers and psychologists, to which we called attention some time since. The first instalment of the portraits, containing the names of Thomas Aquinas, Bacon, Hobbes, Descartes, Spinoza, Locke, Hume, Leibnitz, Wolff, Kant, Schopenhauer, Spencer and others, is now nearly ready.

THE Smithsonian Institution has issued a list, compiled by Mr. W. J. Rhees, of its publications available for distribution. These publications are in many cases of great scientific value and are sold at very low prices. This list of publications, for example, extends to 29 pages and may be secured for two cents. The publications of the Smithsonian Institution consist of: 1, Contributions to Knowledge; 2, Miscellaneous Collections; 3, Annual Reports; 4, Special Papers. The publications include 1,091 separate titles, but many of these can no longer be supplied.

THE work on determination of sex, by Dr. Leopold Schenck, Director of the Embryological Institute of Vienna, of which the newspapers have had so much to say, is announced for immediate publication by Messrs. Schallayin and Wollbruck, Vienna and Leipzig. The title of the book is *Einfluss auf das Geschlechtverhältniss*, and the price will be 3 Marks.

THE museum at Nantes has been enlarged by the addition of a new hall, and special efforts are being made to represent as completely as possible the fauna, flora and geology of western France.

EFFORTS are being made to collect £2,500 to repair the museum building at Barras Bridge, Newcastle, and several subscriptions have been received, including £500 from Lord Armstrong, President of the Natural History Society of Northumberland, Durham and Newcastle, under the auspices of which the museum is conducted.

THE Royal Photographic Society has opened the international exhibition at the Crystal Palace, London, the arrangements for which we have already announced.

THE third annual Congress of the Southeastern Union of Scientific Societies, whose President is the Rev. T. R. R. Stebbing, will be held at Croydon, England, on June 2d, 3d and 4th. Professor G. S. Boulger will deliver the annual address as President-elect.

A MEETING of the Fellows of the Royal Botanic Society, London, was held on April 23d in the Museum at the Society's gardens, Regent's Park, Mr. G. W. Bell presiding. Dr. Coode Adams delivered a lecture on 'Some Remarkable Cacti,' illustrated by lantern slides and

colored drawings, and some living specimens from the large collection possessed by the Society.

AN Association of Medical Librarians was organized at a meeting of a number of representatives of medical libraries held at the editorial rooms of the *Philadelphia Medical Journal*, in Philadelphia, on May 2d. The officers elected were: President, Dr. George M. Gould, of Philadelphia; Vice-President, Dr. J. L. Rothrock, of St. Paul, Minn.; Secretary, Miss M. R. Charlton, of Montreal, Canada; Treasurer, Dr. William Browning, of Brooklyn, N. Y.

JOHN GUITERAS, professor of pathology in the University of Pennsylvania and an eminent yellow fever expert, has been instructed by the Surgeon-General of the United States Army to proceed to Tampa, Florida, to act as medical adviser to the commander of the army which it is expected will invade Cuba. Relative to the dangers which may beset troops in Cuba, and the precautions which should be adopted, the following statement, says the *Philadelphia Medical Journal*, is attributed to Dr. Guiteras: "It is possible to prevent the infection of military garrisons, though whether it can be done in a campaign remains to be seen. Yellow fever is circumscribed within certain areas, and if it is possible to keep troops away from those areas there will be little danger of infection. Contrary to the prevailing idea, altitude does not govern the disease. There are no extremely high altitudes in Cuba, and yet there are places where there is no yellow fever. In some places on the coast the disease is not to be found. As a general rule the more important the town, the greater its commercial activity, the more infected it is. Yet a congregation of people in the interior could not originate yellow fever. The cities where the disease prevails are infected because they are permanently inhabited by a crowd. Still the disease may be carried to a garrison from an infected town. To guard against this the troops must be placed by themselves, in uninfected places, and they must not communicate with infected places. Then, too, no depot of supplies should be placed in an infected port. This is, of course, a desideratum that it may be difficult to obtain for strategic reasons. Ideal conditions are not always possible in a military campaign. Whether or not yellow fever can be kept from the troops depends entirely upon whether these plans can be carried out."

## *UNIVERSITY AND EDUCATIONAL NEWS.*

COLONEL JOSEPH M. BENNETT has given the Trustees of the University of Pennsylvania real estate valued at $80,000, and adjacent to the building he had previously given to the University for a Women's Hall. It is expected that there will ultimately be erected on this land a special building for the women's department of the University, though the buildings as they now exist are available for this purpose. Women are at present admitted to the graduate courses of the University of Pennsylvania, and it is planned to establish undergraduate courses. Colonel Bennett had also previously given to the University $17,500 for fellowships for women, and the announcement is just made that a fellowship for three years has been guaranteed by former women students of the University.

AT the last meeting of the Trustees of Columbia University it was decided to call the building erected for work in physics 'Fayerweather Hall,' in recognition of the bequest of $300,000 made to the University by the late Mr. Fayerweather.

THE University of Edinburgh has received a bequest by the will of the late Honorable B. F. Primrose of £2,000, one half to be used for the encouragement of original research and one-half for the library.

THE diploma of M.D. of the Paris University will henceforth be given to foreign students who go through the medical curriculum without previously passing their *baccalauréat* examination. This diploma, in accordance with Article 15 of the Decree of July 21, 1897, does not give any of the privileges attached to the real degree. It happens curiously that at the same time the Prussian government has adopted an exactly opposite policy and has decided that, after this year, the degree of M.D. will be given to no one who has not passed the state examination and so become legally qualified to practice medicine in the German Empire.

Heinrich Ries, Ph.D. (Columbia), has been appointed instructor in economic geology in Cornell University.

Professor J. H. Wells has been appointed professor of mechanical engineering in the University of Montana.

## DISCUSSION AND CORRESPONDENCE.

### A 'CENTURY OF GEOGRAPHY IN THE UNITED STATES.'

To the Editor of Science: In the preamble to his address entitled a 'Century of Geography in the United States' (this Journal, April 22, 1898) Mr. Marcus Baker states that he proposes to give 'a general review of the century's progress in the diffusion of geographic knowledge in and as to the United States.' For his material he looks 'not to the repulsive black volumes that have for years been poured out over the country from the government printing office,' which represent the *increase*, but 'to text-books, to public addresses in Congress and out, to newspaper and magazine articles, and to public lectures,' which represent the *diffusion* of geographic knowledge.

While it would thus appear that Mr. Baker had intended his address to be of a popular rather than of a scientific nature, yet this does not justify him in making misleading or incorrect statements in regard to the sources from which his geographic knowledge is derived. Such statements are even more liable to do harm in popular addresses than in scientific ones, for the reason that his hearers are less likely to verify them by reference to the original sources of information.

I beg to call the attention of your readers, therefore, to certain of these inaccuracies and misleading statements that have attracted my notice.

1. Powell's first voyage through the canyons of the Colorado was not made in the same year that Alaska was purchased, but two years after, or in 1869.

2. The statement that, at the time the U. S. Geological Survey undertook the gigantic task of making a topographical map of the entire United States, 'topographic maps did not exist,' except of 'a fringe of lake and seacoast,' is not only misleading, but does injustice to the work of the earlier organizations, without essentially enhancing that of the present, to which Mr. Baker is now attached. The earlier topographical work which Mr. Baker ignores includes nearly 90,000 square miles in a belt extending entirely across the Cordilleran system mapped both topographically and geologically by the 40th parallel survey and an area of about 70,000 square miles in Colorado and adjoining States mapped in like manner by the Hayden survey. While these maps are on a smaller scale, and hence give less detail than those made by the present organization, they have been proved by long test to possess a substantial accuracy commensurate with their scale, and are not surpassed or even equalled by corresponding maps in any part of the world.

3. Finally, while enumerating in considerable detail all the other organizations which have contributed to our knowledge of the geography of the country, Mr. Baker has studiously avoided all mention of the Fortieth Parallel Survey, the first to introduce modern methods of topographic surveying into American cartography and to whose pioneer work all the subsequent organizations have been more or less indebted, as I showed in my address on the 'Geology of Government Explorations,' published in this Journal in January, 1897.

S. F. Emmons.

### COLOR VISION.

My thanks are due Professor Titchener for his appreciative criticism and reply to my recent paper on Color Vision. He confirms some of my most important points in showing that the number of competitors for the credit of new color hypotheses is even greater than I had supposed. It is reassuring to be told that "The psychologist must know them in the sense that he must know his literature at large. He is no more disturbed by them, however, than is the biologist by the thousand and one theories of heredity and transmission that have been formulated since the days of pangenesis."

I am quite willing to be corrected by so competent a psychologist if I was mistaken in thinking that Wundt's hypothesis has a good follow-

ing among psychologists; and, also, if I ascribed to physicists generally some knowledge of the Hering hypothesis. It would, perhaps, have been a more nearly accurate statement to say that most, if not all, of the physicists who are acquainted with Hering's hypothesis reject it. My own acquaintance with the outlines of this hypothesis began sixteen years ago; but Professor Titchener is entirely correct in the conclusion that I have not 'followed up the Hering theory in its meanderings through a large number of scattered journals, some of which are now not at all easy to procure.' I do not consider this remark at all 'blunt,' nor is there anything in Professor Titchener's paper that calls for excuse. I may, however, regretfully remark that, in common with others of my profession, I shall hardly have the opportunity to look up these journals. When a psychologist of recognized authority informs me that 'there are now only two discussable theories of color vision, those of Helmholtz and of Hering,' I am willing and glad to accept his judgment, and to let the rest go with but little attention.

The conflict between these two hypotheses will, therefore, be watched in future years with the calm interest of an outsider, rather than that of a partisan. In teaching that portion of optics which relates to color I shall carefully limit myself to the physical facts; and if Hering's hypothesis should win its spurs, and thus be changed into Hering's theory, the physicists will doubtless forget their ancient hardness of heart and will welcome the settlement of a long vexed question.

Apart from Professor Titchener's discussion, several private communications have brought the assurance that my criticism of the color hypothesis which has for many years held a place in my regular course of instruction has had more than one sympathetic reader. The good spirit which has characterized the reception of my paper is a source of gratification.

W. Le Conte Stevens.

### THE GEOLOGICAL AND BIOLOGICAL SURVEYS OF ALABAMA.

To the Editor of Science: In his Presidential address, published in Science, April 29th, Professor V. M. Spalding credits the Biological Survey of Alabama with the botanical work of Dr. Charles Mohr, of Mobile. That Survey is doing most excellent work, but Dr. Mohr has for many years been engaged, under the auspices of the *State Geological Survey*, in the investigation of the Botany of Alabama. As one of the results of this work we have now going through the press a complete flora of the State, and this will be followed by a companion volume in which the useful and noxious plants will be treated in a very thorough manner, as all who know the character of the work of Dr. Mohr will be ready to believe.

The Geological Survey began this work many years before the Biological Survey was inaugurated.

Eugene A. Smith.

University of Alabama, May 6, 1898.

---

## SCIENTIFIC LITERATURE.

*An Elementary Course of Infinitesimal Calculus.* By Horace Lamb, M.A., F.R.S., Professor of Mathematics in the Owens College, Victoria University, Manchester; formerly Fellow of Trinity College, Cambridge. Cambridge, University Press. 1897. Crown 8vo. Pp. xx + 616.

The English text-books on the Infinitesimal Calculus in common use afford a formal treatment of the calculus that is all that can be desired. A student who has worked all the examples under important topics in one of these books has been through a course of shop-work that prepares him adequately for the manipulation of calculus formulas—and for the tripos examination. But he has done only shop-work. He has learned to differentiate explicit functions and to integrate (some) explicit functions, and to prove all sorts of things by Taylor's Series. He has *not* been trained to examine carefully the reasoning he employs or to consider even the broadest limitations in the statement of theorems. Teachers of elementary calculus are only too prone to leave the consideration of all such matters to the indefinite future; but a wise system of instruction will strive not to hide from the student, but to point out to him those difficulties that are inherent in the fundamental

conceptions and methods of the science, and to provide him with the simplest means known at the present time for dealing with them.

Professor Lamb has produced a text-book the distinctive feature of which, to our mind, is that a serious and successful attempt has been made to meet these latter demands. The author says: "Considerable attention has been paid to the logic of the subject. Writers of text-books, however elementary, cannot remain permanently indifferent to the investigations of the modern Theory of Functions (of a real variable), although opinions may differ widely as to the character and extent of the influence which these should exert. It is not claimed that the proofs of fundamental propositions which are here offered have the formal precision of statement which is *de rigueur* in the theory referred to; but it is hoped that in substance they will be found to be correct. Occasionally, where a rigorous proof of a theorem in its full generality would be too long or intricate, it has been found possible by introducing some additional condition into the statement, to simplify the argument, without really impairing the practical value of the theorem." In this important respect the book is the first of its kind on the subject of Calculus to appear in the English language. May future writers on Calculus emulate the example of Mr. Lamb in trying to make their presentation rigorous according to the highest standards of their day, and at the same time not beyond the comprehension of the students whom they would instruct!

The choice of material is varied and comprehensive. Both the indefinite and the definite integral are introduced at an early stage. There is a chapter of 44 pp. on Physical Applications and one of 62 pp. on Special Curves, besides an earlier chapter of 47 pp. on Geometrical Applications and a later one of 62 pp. entitled Curvature and containing, among other things, a treatment of the instantaneous center and of the space and body centrodes, including an application to teeth of wheels. Then follow chapters on Differential Equations of the first and second orders (34 + 51 pp.). In order, however, to deal with some of the most important differential equations that arise in practice, some knowledge of the properties of power series is indispensable; and so a chapter on Infinite Series (25 pp.) is introduced. This is one of the first elementary treatments in English of the continuity of infinite series and of the conditions under which they can be integrated and differentiated term by term. It is decidedly well done, and the collection of examples at the end is a valuable contribution to the presentation of this important subject. The book ends with a chapter on Taylor's Theorem.

This is not the place for detailed criticism. We cannot refrain, however, from deploring, especially in a book characterized in the main by rigor, the utter inadequacy of the treatment of the important subject of infinitesimals. As one of the consequences of this neglect, a satisfactory definition of the differential is impossible. Again, some of the applications of the calculus to geometry might have been dispensed with to make place for a somewhat fuller treatment of multiple integration. An unfortunate lapse occurs in the foot-note on p. 544. The power series has not been proved 'uniformly convergent for values of $x$ ranging up to $a$, exclusively.' The text to which this note is appended is, however, clear and accurate.

The author tells us that "this book attempts to teach those portions of the Calculus which are of primary importance in the application to such subjects as Physics and Engineering." For the vast majority of the students of the calculus their interest is quickened and their insight into the nature of the calculus is deepened if they are shown the applications of analysis to the problems of every-day life. We could wish that the author had laid more stress on such problems, had not a most excellent book representing this side of the calculus recently appeared from the pen of Professor John Perry.* Mr. Lamb's plan, however, is a different one. He says himself: "It is to be clearly understood, indeed, that the object aimed at in this book is not to teach Dynamics or Physics or Engineering, but to exercise the reader in the *kind* of Mathematics which he will find most useful for the study of those subjects."

* *The Calculus for Engineers*, Edward Arnold, London, 1897.

We recommend the book as valuable to the student of physics and engineering, but as especially valuable to the student of pure mathematics, and as a book that will be useful to all teachers of the infinitesimal calculus.

W. F. OSGOOD.

HARVARD UNIVERSITY, 26 April 1898.

*A Text-Book of Botany.* By DR. E. STRASBURGER, DR. FRITZ NOLL, DR. H. SCHENCK and DR. A. F. W. SCHIMPER; translated by H. C. PORTER, PH.D. London and New York, Macmillan & Co. With 594 illustrations, in part colored. 8vo. Pp. x + 632. $4.50.

In 1894 the 'Bonn Text-Book' appeared from the hand of the brilliant German botanist Strasburger, with the assistance of three of his collaborators. In this volume Strasburger prepared the chapter on external and internal morphology (132 pp.), Noll the chapter on physiology (125 pp.), Schenck that relating to cryptogams (104 pp.) and Schimper that on phanerogams (264 pp.). The success of this volume was so great that in but little more than a year a second edition was brought out, with some new matter and additional illustrations. About a year ago the welcome announcement was made that Dr. Porter, of the University of Pennsylvania, was bringing out a translation of this second edition, but its appearance has been much delayed, and the volume was not issued until early in April of the present year. The length of this delay is indicated by the date of the translator's preface, February, 1896, and accounts for the fact that some important additions to botanical science are not noticed in this otherwise very modern book. There is no reference to Harper's proof of the fecundation in the Erysipheæ, nor to the discovery of antherozoids in lower gymnosperms.

The volume in its German dress is so well known to botanists that it is quite needless to speak of its merits. Perhaps no man living is better prepared than Dr. Strasburger to undertake the presentation of the portion of the work which deals with the internal morphology of plants. Certainly no man has a better knowledge of the structure of the cell, and the many changes which it undergoes in constitution and form. This book, unlike many other text-books, is, in this chapter at least, authoritative.

The translation is good, and the publishers have spared no pains to make the type and printing all that could be desired, these being far more pleasant to the eye in the translation than in the original. The colored figures, also, are somewhat improved by a softening of the rather bright colors of the German editions.

The publishers announce an early issue of this work in two volumes, of about 300 pages each, to be sold separately, volume I. containing Strasburger's chapter on Morphology, and Noll's on Physiology, and volume II., Schenck's Cryptogams and Schimper's Phanerogams. This will be a great improvement, since it will enable the student of morphology and physiology to supply himself with the part relating to these subjects at much less expense.

CHARLES E. BESSEY.

## SCIENTIFIC JOURNALS.

*Journal of Physical Chemistry*, April. 'Study of a three-component System:' by HECTOR R. CARVETH. A study of the freezing-points of lithium, sodium and potassium nitrate mixtures and their classification and interpretation according to the Phase Rule. The suggestion is made of the possibility of applying the freezing-point method to the analysis of mixtures of inorganic salts. 'Note on Thermal Equilibrium in Electrolysis:' by D. TOMMASI. The effect of the simultaneous action of an oxidizing and a reducing agent upon a substance capable of being oxidized or reduced. A mixture of electrolytic hydrogen and oxygen was allowed to act on various substances, as nitric acid, potassium chlorate, etc. The laws are deduced that when a substance is submitted to two equal and contrary chemical actions the reaction which evolves the most heat will take place in preference, provided always it can begin; and of two chemical reactions that one which requires less heat to start it will always take place in preference, even though it evolves less heat than the other reaction. 'Benzene, Acetic Acid and Water:' by JOHN WADDELL. An investigation of the distribution ratio of acetic acid in benzene and water as solvents.

'A Constant Temperature Device:' by HAMILTON P. CADY. A device for keeping up the circulation of water at a constant temperature. 'The Equilibrium of Stereoisomers, II:' by WILDER D. BANCROFT. A study of the change from one isomer into another due to the addition of one or more components. Reviews of books and journals.

*American Chemical Journal*, May.—'A Determination of the Atomic Weight of Praseodymium and Neodymium:' by H. C. JONES. The material for this work was obtained from the Welsbach Light Co., and was carefully purified and tested with the Rowland spectroscope. The sesquioxide was converted into the sulphate and the calculation made from this. The values obtained were for the Praseodymium 140.45, and for the Neodymium 143.6. 'Veratrine and some of its derivatives:' by G. F. FRANKFORTER. A careful study of this substance and some of its derivatives has shown that it is identical with cevadine. 'On the action of Hydrogen Sulphide upon Vanadates:' by J. LOCKE. Several sulphovanadates have been prepared by the action of hydrogen sulphide on vanadates heated in a combustion furnace. 'On the formation of Imido-1, 2-diazol Derivatives from Aromatic Azimides and Esters of Acetylenecarboxylic-acids:' by A. MICHAEL, F. LUHEN and H. H. HIGBEE. 'On the Oxide of Dichlormethoxyquinonedibenzoyl-methylacetal:' by C. L. JACKSON and H. A. TORREY.

J. ELLIOTT GILPIN.

*Appleton's Popular Science Monthly* for May gives as a frontispiece a portrait of Professor Russell M. Chittenden, the eminent physiological chemist of Yale University, together with a sketch of his life and work. There is an elaborately illustrated article on 'Kite Flying in 1897,' by Mr. George J. Varney, based chiefly on the work of the Blue Hill Observatory. Dr. J. W. Spencer contributes an article on 'The West Indian Bridge between North and South America;' Dr. H. Carrington Bolton an article entitled 'A Relic of Astrology,' and Messrs. W. H. Beatley and G. H. Perkins an illustrated study of snow crystals. There are further two articles on the study of children and two on economic subjects.

*McClure's Magazine* for May devotes an article to John Milne, the author being Mr. Cleveland Moffett. There are numerous illustrations, including a portrait of Professor Milne, of his house at the Isle of Wight, and of seismographs and seismograms. Many details are given regarding the earthquake observatory and Professor Milne's experiences, put largely in the form of an interview.

---

## SOCIETIES AND ACADEMIES.

### ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

*April 19.* Mr. F. J. KEELEY exhibited microscopic preparations of jade from Mexico. The mineral resembles nerphite and is therefore merely a variety of serpentine.

MR. H. A. PILSBRY described the radula of *Nerita peloronta*. It is over two inches long and is in extreme disproportion to the small snail bearing it. Types of rhipidoglossate and other radulæ were described. He regarded the radula of cephalopods not so much as a rasp as a help to swallowing food. In *Limnea* and other gastropods it certainly acts as a rasp. In *Bulla* and other Tectibranchs the structure of the gizzard makes rasping function of the radula comparatively unnecessary.

MR. D. S. HOLMAN made a communication on the keeping of aquaria and described filaments of Spirochætæ an inch or so in length occuring in a pellicle on the surface of a tank partially shaded from the sun.

The PRESIDENT exhibited a pearl from a little neck clam. It is about ⅜ of an inch in diameter, the shades of color resembling an eye, the optic nerve being suggested by a projection at the back. The inside of the shell was devoid of coloring matter.

*April 26th.* DR. A. F. WITMER made a communication on the training of chronic epileptics, dwelling on the pathology of the disease and the advantages derived from fixing the attention by means of work on perforated embroidery cards with colored silks.

DR. BENJAMIN SHARP spoke of rock carvings occurring on the west side of Kauaii, one of the Sandwich Islands. The carvings are on rocks usually covered to a considerable height with beach sand and can only be seen when de-

nuded by peculiar conditions of wind and tide. A correspondent, Mr. F. K. Farley, had recently described such an exposure occurring on June 16th–21th of last year and had sent him illustrations of the carvings, which were exhibited. Mr. Farley describes such portions of the carvings, mostly crude linear representations of the human figure, as could then be seen, estimates the time required to make them and makes suggestions regarding their origin. The speaker, in continuation, presented philological evidence in support of the belief that Hawaii had been visited by Spaniards at an early date.

The distribution of *Fulgur perversum* on the New Jersey coast was commented on by Messrs. Woolman, Pilsbry and U. C. Smith.

*May 3d.* MR. GEORGE VAUX, JR., prefaced a communication on lead minerals by the remark that at a certain gathering of mineralogists a preponderance of votes was given in favor of regarding Vanadenite and Wolfenite as the most beautiful American minerals, although no one species received a majority of all the votes cast. He then exhibited and described a series of beautiful specimens of lead ores from his private collection and the William S. Vaux collection of the Academy, dwelling on the peculiarities of the examples displayed and giving the localities represented.

MR. JOSEPH WILCOX referred to carbonate of lead from Davidson Co., N. C., and related his unsuccessful effort to buy certain fine specimens from the original owners of the mine, who declined parting with them on the ground that they were all they had secured in return for their investment. Except in the case of mica and corundum, and possibly a little gold, he believed none of the mines of the State had paid their owners.

MR. LEWIS WOOLMAN described and illustrated, by means of microscopic preparations, a number of forms of fossil foraminifera, dwelling on their characters, classification and distribution. Referring to the distribution of fossil *Fulgur perversum* on the New Jersey coast he quoted from Captain Swain, of the Avalon Life Saving Station, that they were found on the beach during a strong northeast wind immediately following a northeast gale.

MR. F. J. KEELEY exhibited under microscopes and commented on a series of specimens illustrating the mode in which organisms are preserved in fossil form. The exhibit included fossil wood, coal, jet, limestone containing shells, a larva in amber, structure of tooth of *Oreodon* and bone of *Iguanodon*, diatoms from Japan, coral, etc.

Papers under the following titles were presented for publication: 'Materials toward a natural classification of the Cylindrelloid Snails,' by Henry A. Pilsbry and E. G. Vanatta; 'Notes on Mr. Meehan's paper on the Plants of Lewis and Clark's Expedition across the Continent, 1804–06,' by Dr. Elliot Coues; 'List of Bats collected by Dr. W. S. Abbott in Siam,' by Gerrit S. Miller, jr.

A paper on the vertebrate remains of the Port Kennedy Bone Cave, by the late Professor Edw. D. Cope, was accepted for publication in the *Journal*. Papers on the summer birds of Central California, by John Van Denburgh, and a revision of the North American slugs, by Henry A. Pilsbry and E. G. Vanatta, will be printed in the *Proceedings*.

EDWARD J. NOLAN,
*Secretary*.

BOSTON SOCIETY OF NATURAL HISTORY.

THE Society met April 6th; fifty-seven persons present.

Dr. C. B. Davenport read a paper, 'A precise criterion of species; its applicability to systematic zoology,' and Mr. J. W. Blankinship followed with a paper on 'A precise criterion of species; its application to systematic botany.' These papers will be published in an early number of SCIENCE.

Professor E. S. Morse considered that success in determining the true relations of species would be attained from methods similar to those of Dr. Davenport and Mr. Blankinship. He discussed at length the characteristics of certain land and marine shells of New England and Japan.

Dr. B. L. Robinson said that nutrition in plants was of great importance and rendered measurements of doubtful value; maturity was also of great importance and promiscuous variability should always be taken into account.

Mr. C. J. Maynard said that newer forms

were more plastic than those that had been longer established; he mentioned several cases among shells and birds that could with difficulty be considered by mathematical tests.

Dr. R. T. Jackson alluded to cases among shells showing a radical difference in the right and left sides and to radial variations showing differentiation in a single individual.

Professor Alpheus Hyatt considered that in the papers of Dr. Davenport and Mr. Blankinship opinion was largely replaced by a definite, exact method which should be thoroughly tested. Its applicability would seem confined to characters that can be measured. He doubted if the color characters of the Achatinellinæ could be expressed in numbers.

SAMUEL HENSHAW,
*Secretary.*

NEW YORK ACADEMY OF SCIENCES—SECTION OF GEOLOGY AND MINERALOGY, APRIL 18, 1898.

THE first paper of the evening was by Dr. A. A. Julien on the 'Elements of Strength and Weakness in Building Stones.' Dr. Julien called attention to the fact that in the testing of building stones little consideration is given to the causes influencing their various properties. In judging the resistance which a stone shows towards weathering, care should be taken to recognize the character of the forces to which it has been subjected. The strength of a stone bears no relation to its mineral components, but is dependent on the shape and arrangement of the mineral grains and the character of the cementing material. In considering the strength of a stone four facts have to be kept in mind, viz: interlockment of the particles; coherence, dependent on character of the cement and adhesion of the grains; rigidity; and tension.

The 'quarry sap' he believes, plays a more important rôle than has hitherto been recognized, as it probably carries much of the cement in solution and deposits it only when the stone is exposed to the air. This accounts for the hardening of the stones after being quarried. A distinction should also be made between porosity due to cavities between the grains and interstices in the individual minerals. The former is a source of weakness, the latter not, although either may cause the rock to exhibit a high absorptive capacity.

All these points, which have important bearing on the strength of building stones, are best studied with the microscope. The paper was illustrated by means of sections thrown on the screen with a polarizing lantern. Discussion was by Professor Kemp and Mrs. Dudley.

The second paper of the evening was by J. D. Irving on 'Contact-metamorphism of the Palisades Diabase.' Mr. Irving referred to the work done by Professors Osann and Andrae some years ago and stated that his results agreed with theirs, but recent railroad excavations at Shadyside had enabled him to obtain additional facts. The diabase flow becomes denser, finer grained and prophyritic towards the contact with a decrease in hypersthene. It is also conformable to the Newark shales. In addition to the zones found by Osann, Mr. Irving found: 1. A normal hornfels zone rich in spinel; 2. a hornfels zone with brown basaltic hornblende layers; 3. hornfels with an undeterminable isotropic mineral resembling leucite; 4. hornfels with andalusite becoming more arkose farther from the contact. The diabase is to be considered as an intruded mass and not a surface flow. The paper was discussed by Professors Kemp and Dodge, and Dr. Hovey and Mr. White.

HEINRICH RIES,
*Secretary of Section.*

CHEMICAL SOCIETY OF WASHINGTON.

THE regular monthly meeting was held on March 10, 1898.

Dr. E. A. de Schweinitz presented a paper on 'The Pasteur Milk Laboratory of Washington.' The speaker first reviewed briefly some of the ways in which milk can become infected, either from the fact that the animals are dirty and the stables in a filthy condition, or from the carelessness of the milkers, the dirty condition of the pans and pails and the use of impure water for washing these utensils. Attention was also called to the fact that dogs, cats, rats, mice, etc., which often obtain access to the place where the milk is ordinarily kept in the country, may affect the milk, as it is well known that these animals are often carriers of disease. In view of all these well known dangers, and es-

pecially the fact that many outbreaks of typhoid fever have been traced directly to an impure milk supply, the Medical Society of the District of Columbia has endeavored to introduce a good milk by appointing a committee that should supervise a dairy and laboratory which was to be conducted on thoroughly hygienic principles. Such a dairy has been established and all possible precautions are observed. The milk is obtained from healthy tuberculin-tested cattle. These are kept in a well-ventilated, clean stable with a cement floor. Before milking the animals are carefully cleaned and curried, and taken into a smaller building designed for a milking room and kept as far as possible free from dust. The milk is immediately passed through a separator and cooled to about 45°. It is then brought to the bottling laboratory in cans, when it is placed in thoroughly clean sterilized bottles, which are sealed with paraffined paper caps. This milk is called sanitary milk, to distinguish it from other milk which is still further improved by pasteur ization. Ordinary milk may contain from 60,000 to two or three millions of bacteria per cc., whilst by the above method a milk has been obtained which contained only from 1,200 to 3,000 bacteria per cc.

Dr. Hillebrand read a paper on 'The Colorimetric Estimation of Small Amounts of Chromium with Special Reference to Rocks and Minerals.' The time required for the separation of chromium from certain other constituents which have likewise to be determined in rock and ore analysis is very considerable; the amounts in question are often extremely small, and the separations are, therefore, more or less imperfect; hence, a rapid and accurate method for these small amounts is very much needed, and seems to be fully afforded by a comparison of the color of an alkaline solution of the chromium as chromate with a similar solution containing a known amount of chromium. The method was thoroughly tested with prepared chromium solutions whose contents ranged in amounts from 1 mg. to 7.5 mg. counted as $Cr_2O_3$, in varying dilution, though the figures given by no means represent the limits of the method. The standards employed contained $K_2CrO_4$, corresponding to .1 and .2 mg. per cc., respectively, of $Cr_2O_3$, and in making the determinations were always diluted to agree with the purposely made weaker test solutions. The maximum and minimum deviations from the truth were +.32 mg. and —.28 mg.; the average error being a little less than +.02 mg.

The method was given a severe practical test by adding to several grammes of an iron ore, and also to a silicate, known amounts of chromium and subjecting the mixture to fusion with sodium carbonate and potassium nitrate, precipitating $P_2O_5$, $V_2O_5$ and $CrO_3$ from the aqueous extract with mercurous nitrate, igniting the precipitate, fusing the residue with sodium carbonate and thus obtaining a small bulk of highly colored solution. The results were equal to those of the preliminary tests and show the method to be highly accurate for small and moderate amounts of chromium. When there is enough chromium in a sample to give a sufficiently colored extract of the first alkali fusion the color comparison may be made at once with this solution and thus much time may be saved. Maganese, however, must be thoroughly removed, most quickly by reduction with methyl alcohol. The glasses used by the author were shown and the simple precautions for securing proper illumination were described. For amounts less than .1 mg. it is best to use Nessler tubes.

Mr. Tassin exhibited specimens of products obtained in Moissan's electric furnace consisting of carbides of aluminum, boron, iron, cobalt, cerium and calcium, the elements molybdenum, uranium, tungsten, titanium and chromium and a piece of iron containing a diamond. The high temperature which it is possible to obtain with this furnace was illustrated by a specimen of fused lime.

Dr. Bolton presented a postscript to his paper on 'Early American Chemical Societies,' which he read at the meeting held on April 8, 1897. He called attention to a club of German chemists which was organized in New York in the winter of 1863–64. The president of the club was Dr. Friedrich Hoffman and prominent among its members were Ferdinand F. Meyer, M. Alsberg and Isidore Walz.

WILLIAM H. KRUG,
*Secretary.*